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CIVIL ENGINEERING

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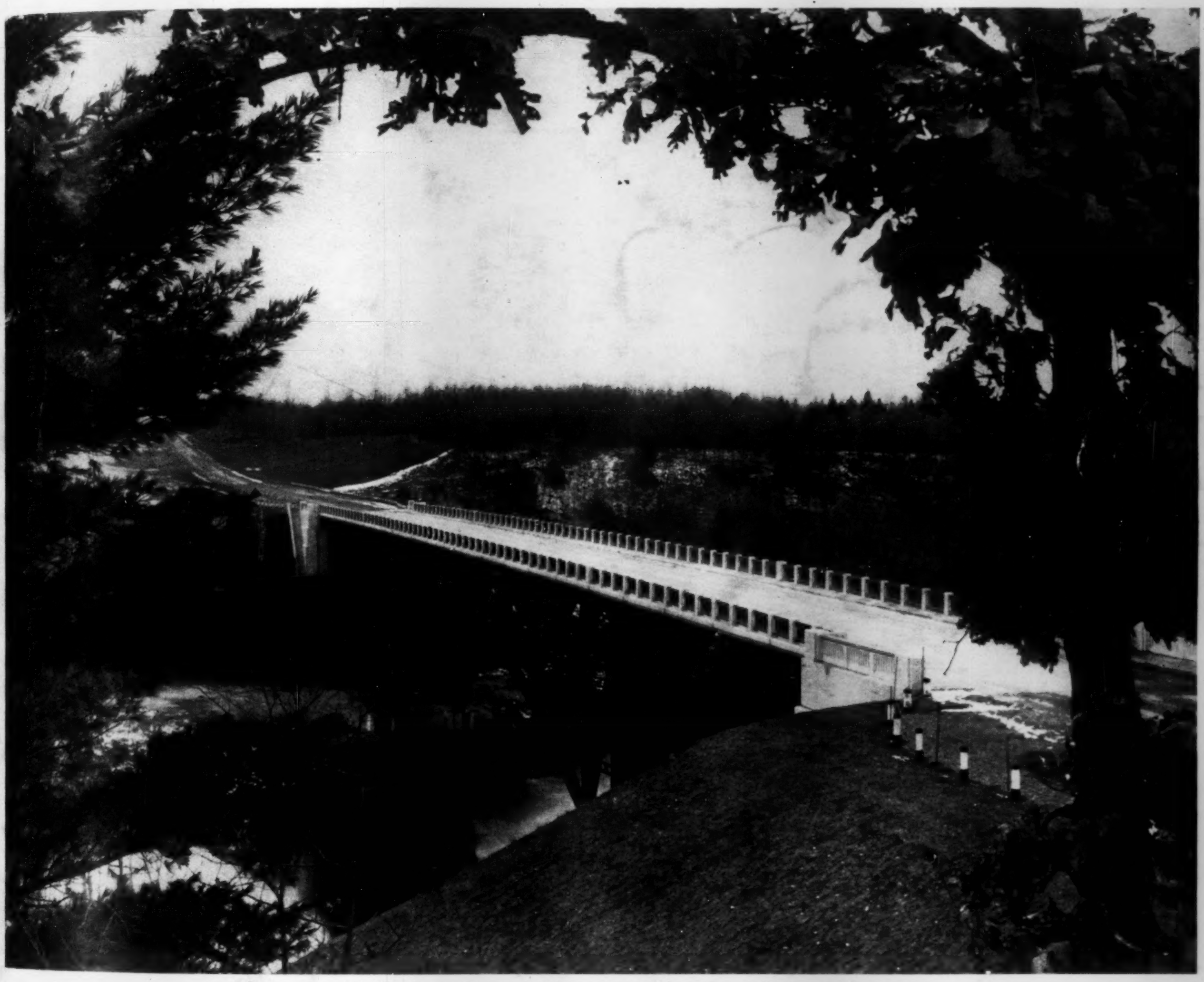

Mortimer E. Cooley Bridge Over the Manistee River, Michigan
Lack of Superficial Ornamentation Gives Grace and Dignity to Steel Cantilever Structure

Volume 7 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — *Number 9*

SEPTEMBER 1937

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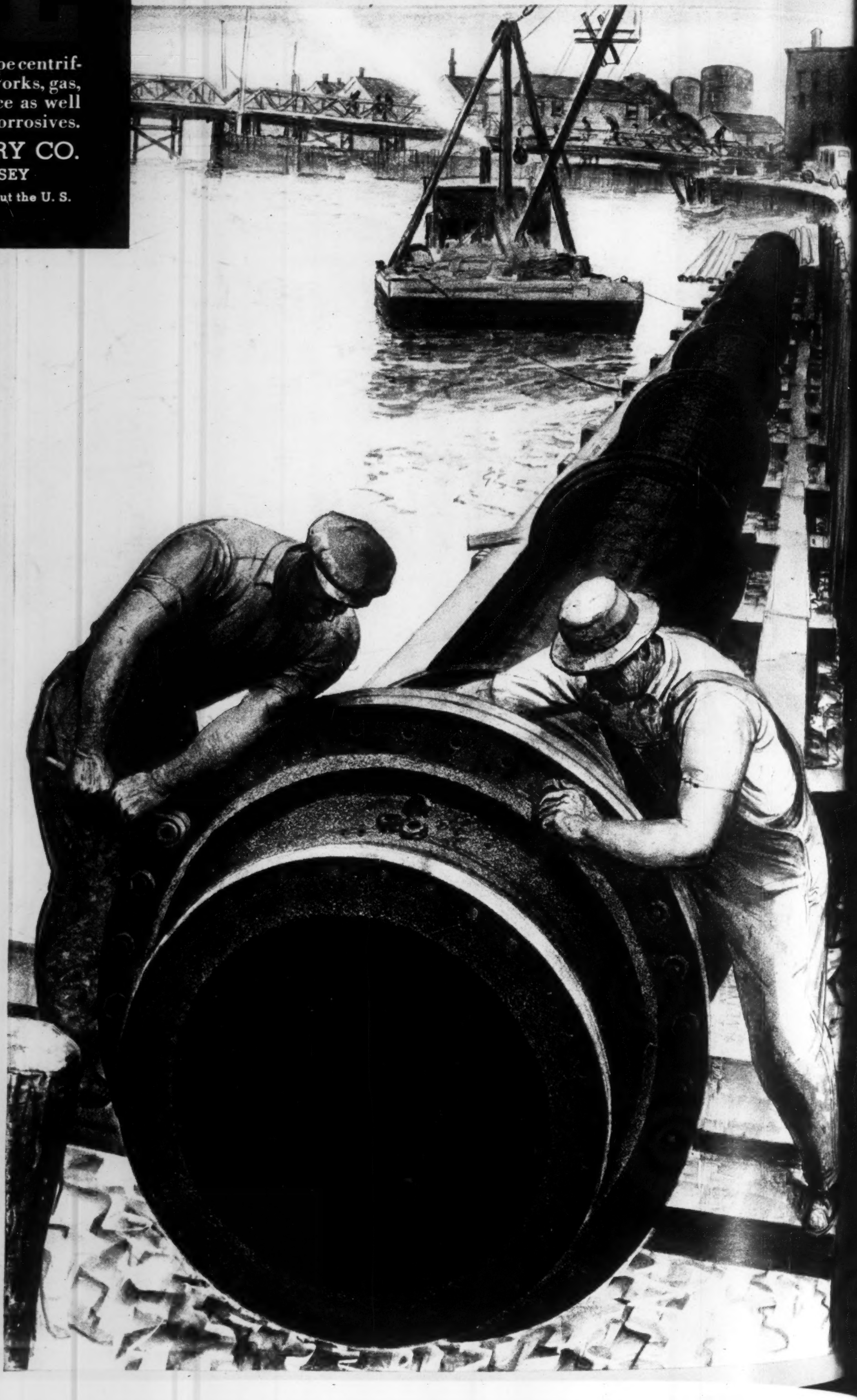

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Picturesque Light Protects the Rock-Bound New England Coast

This Old Landmark Typifies Those to Be Seen on the Shore of Colonial New England, Which Will Prove a Magnet to Many Members Attending the Fall Meeting of the Society in Boston, Mass., October 6–8, 1937

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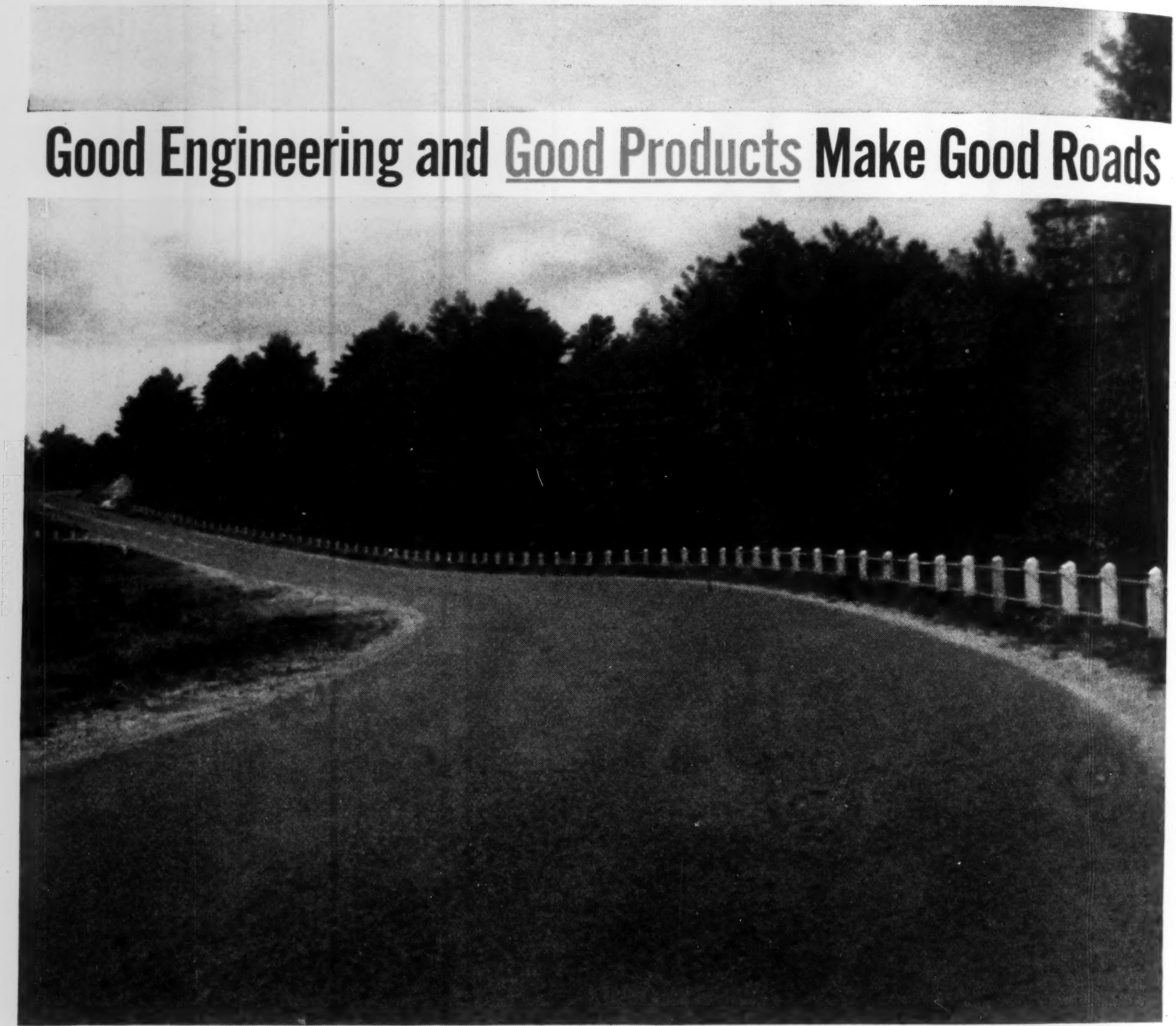

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Among Our Writers

Louis C. Hill, President of the Society, is too well known, particularly to members in the hydraulic field, to require further introduction. In his professional connection, over the past 35 years, with large dam projects employing thousands of men, President Hill has had plenty of opportunity to note the possibilities inherent in the engineer's dual capacity as employee-employer.

T. B. Larkin, after service with the U. S. Corps of Engineers in Mexico and France, was attached for several years to the office of the chief of engineers in Washington, D.C. For 3 years prior to taking charge of the Fort Peck project (in November 1933), he served as district engineer of the Vicksburg district.

John E. Field has specialized in irrigation and water-supply engineering for almost 50 years. Farming has been an important side line with him since 1881, so that he is well qualified to discuss dry-land problems. For the past 4 years he has been PWA examining engineer, since November 1935 in Washington, D.C.

Allan T. Ricketts began specializing in sanitary engineering in 1915, when he was engaged by Nicholas S. Hill, Jr., consulting engineer, in the design and construction of water and sewage works. For the past 5 years he has been supervising engineer with a federal bureau, in charge of the section examining applications for loans for water works, sewerage, and irrigation systems.

L. W. Millard has been engaged in bridge design and construction work almost continuously since his graduation from the University of Michigan in 1922. From 1926 until 1933 he served with the Oakland County Road Commission, and since that time has been bridge engineer of the Michigan Highway Department.

John H. Gregory, who died suddenly on January 18, 1937, was active in the design and construction of municipal sanitary engineering works for over 40 years. In addition to his consulting practice, since 1919 he served as a member of the faculty of Johns Hopkins University. He was a Director of the Society from 1932 to 1934.

Evelyn E. Brackett is the wife of a city manager. For 3 years she served as secretary to a prominent consulting engineer, and previous to that, worked on surveys and topographic mapping. Her experience also includes newspaper work. She is now writing a book, recording her observations of recent unusual happenings in England and on the Continent.

H. A. Sweet, after graduation from Massachusetts Institute of Technology in 1914, went into structural work. Since 1917 he has been with the Associated Factory Mutual Fire Insurance Companies of Boston, Mass., principally engaged in the prevention of damage to industrial plants due to wind-storms, earthquakes, and fire and sprinkler losses.

R. C. Corson graduated from Drexel Institute, Philadelphia, and Lowell Institute (Massachusetts Institute of Technology). Since 1912 he has specialized in structural work—since 1930 in connection with fire insurance, working with Mr. Sweet for the Associated Factory Mutual Fire Insurance Companies.

Jacob J. Creskoff graduated in civil engineering at the University of Pennsylvania in 1922. Specializing in earthquake- and vibration-resistant structures, he has acted as consultant to various federal departments on aseismic design. He is the author of a book on the dynamics of earthquake-resistant structures and of some two dozen technical articles on this and allied subjects.

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Founded 1852

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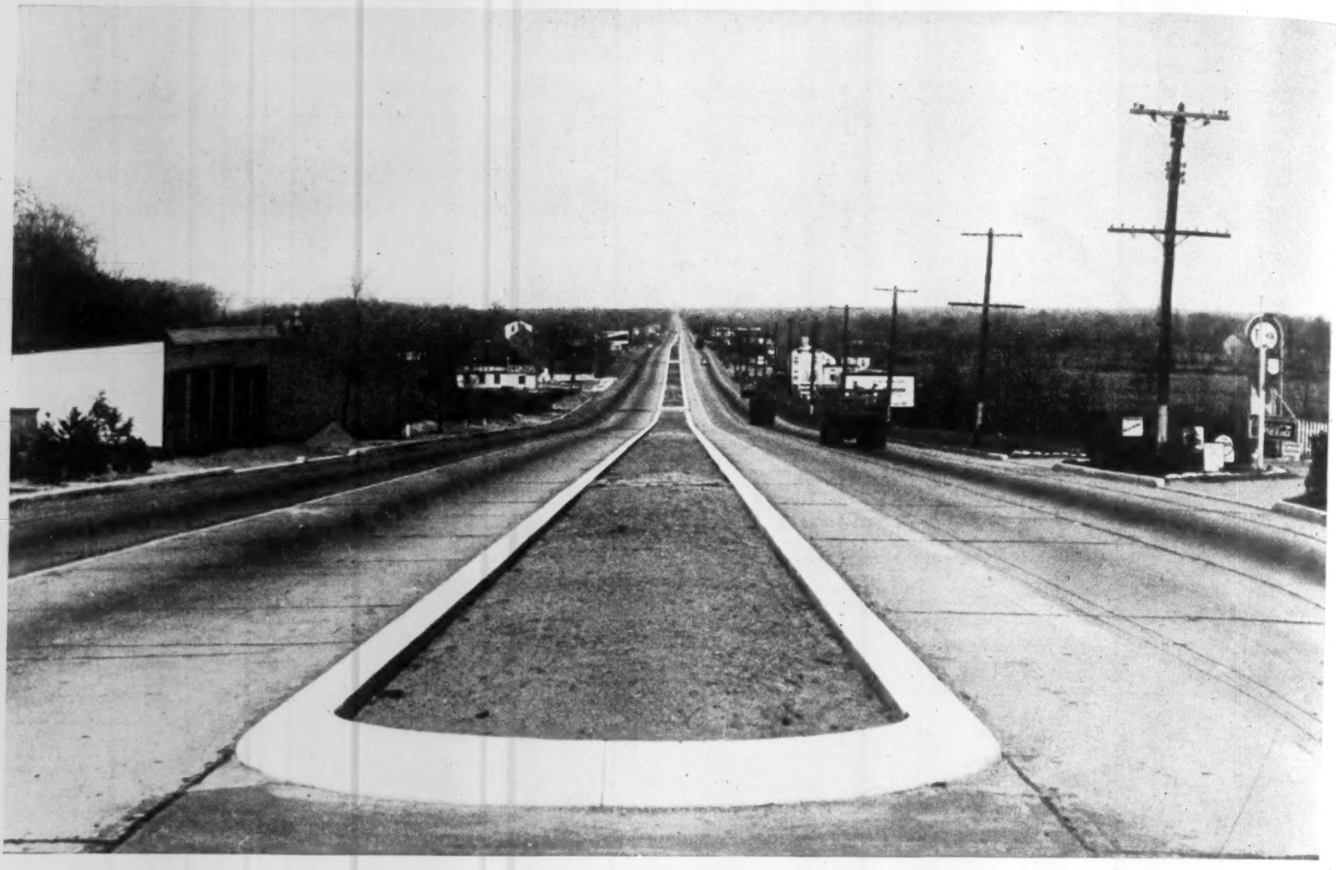

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

The Engineer, an Employee-Employer

Digest of Address at the Society's Annual Convention in Detroit, Mich., July 21, 1937

By Louis C. Hill
President, American Society of Civil Engineers
Quinton, Code and Hill–Leeds and Barnard, Consulting Engineers, Los Angeles, Calif.

IT IS not uncommon today to read in a newspaper a glowing account of some outstanding engineering work and in the same issue of that paper to be confronted with the news that engineers are organizing into labor unions. Thus, we have public recognition that this is the age of the engineer, that the material progress of the world today is dependent upon his achievements; and yet engineers are resorting to collective bargaining because of a lack of economic recognition of the individual engineer.

In 1930, John F. Coleman, Hon. M. and Past-President, Am. Soc. C.E., opened his address before the Annual Convention of the Society with the statement:

"For years there was a constant cry to the effect that the engineer did not receive the recognition which he deserved. Lately, the same cry is heard although less frequently. In the past there was much to justify such complaint, and even now there is some excuse for it.

"It seems probable, however, that the engineer himself is in great degree responsible for such a state of affairs in that he has been until recent times almost inarticulate in the councils of men . . . ."

Looking Towards Material Reward.~During the seven years since the Society was so challenged, this country has passed through a period of severe depression out of which arose the most ambitious program of public works the world has ever known. Engineers by the thousands and tens of thousands have been employed in the design and on the construction of such works, all of which have been publicized to the extent that the names of many projects have become household words.

Yet, whenever engineers get together, at meetings of the Society or in other groups, at social gatherings or in their homes, an inevitable subject of conversation is the lack of professional recognition of the engineer by the public. Do these men mean professional recognition in the sense of public acknowledgment of the importance of engineering work in general, or do they mean something more material which affects them as individuals? I believe that little of the discussion so prevalent today has its origin in any failure of the world at large to appreciate the engineering profession in the abstract. Rather, I think it is the economic status of the engineer, his material and mundane reward, which is of consuming interest.

The basic reason for this situation was suggested by the late Harrison P. Eddy, Past-President Am. Soc. C.E., in his address before the Annual Convention of the Society in 1934, when he defined engineering as a true profession, although of a different character from those of law and medicine. In that address he brought out that lawyers and doctors in large measure are independent professional practitioners, whereas engineers are generally employees. The validity of his distinction is evident from the fact that when one is sick the personal services of a doctor of medicine are sought, and the services of a particular lawyer are engaged when one is faced with legal difficulty. On the other hand, the engineer is employed only rarely by another individual, even though every citizen of this country, whose reading goes beyond the tabloids and the sport sheets, must be conscious of the tremendous part which the engineering profession plays in the affairs of the modern world.

Analyzing as a Group.~Only a very few people have any appreciation of the function of the engineer as an individual. He, himself, has little more association with those who make daily use of his works than the men who produce the materials which go into his works have with him. Even the engineer in private practice meets professionally only a few laymen. From the nature of his employment, he deals generally with corporations, both public and private; where he has one client, a lawyer may have twenty and a doctor a hundred. Most engineers, therefore, by the very conditions which make their work possible, are substantially barred from individual personal contacts with the public.

To have a basis for action and at the same time to be frank with ourselves, we must accept the condition that engineers comprise fundamentally an employee group in which the world at large has the greatest confidence, but regarding whom the public has little individual concern. Going a little further with our introspective analy-

In response to a number of suggestions, this early publication of President Hill's address is arranged so that all members may profit by his enlightening views on a most timely issue. Some condensation has been found necessary in view of the limited space here available. However, the complete Annual Address will later be printed in the 1937 "Transactions," to be issued in the fall.

sis, we must consider the significance of the unique fact that ours is the only profession in modern society which both works for itself and employs itself. It is because of this anomaly that each engineer is in great measure responsible for the status of his profession, both abstractly and concretely.

The current Society roster reveals that many more than one-third of the Members, almost one-half of the Associate Members, and nearly two-thirds of the Juniors are public employees. Many others are employees of private corporations, a few in high executive positions, the great mass in subordinate or employee positions. Little more than 10 per cent of the total membership are evidently in private practice as consulting engineers or as principals and associates of engineering firms.

A Dual Rôle.~Paradoxical as it may seem, a large proportion of the engineers who are employees are at the same time employers of engineers. Particularly is this true of those in responsible charge of work. Few engineers may be employers in the sense that they have authority to engage, to retain, or to dismiss subordinates according to their individual ideas of policy. In a very large measure, however, all of us who are Corporate Members of the Society are responsible for the work done by our subordinates and their assistants, and rarely will changes in their positions or salaries be made by our superiors or employers except on our recommendation.

In general, therefore, the engineer in responsible charge of work occupies the dual position of an employer of engineers while he himself is an employee of a public or a private corporation. To the same extent that he is responsible to his superiors for the execution of engineering work done by his subordinates, the engineer in charge is responsible to his subordinates for any recognition or lack of recognition given them by his superiors.

Improving Public Appreciation.~Much of this is not new to us. Others have pointed out that the responsibility is ours now. Thus, it may well be asked: What has been done to advance the engineering profession in the eyes of the public and what has been done to improve the social and economic status of the individual members of the profession? As to the former question, great progress has been made. Engineering works are news today and, in the abstract, the world at large has conceded to our profession the recognition we deserve. In all this the Society has played a major part. Also, as a society, we aided many engineers in obtaining employment during the depression, and we were effective in establishing salary scales for engineers on emergency relief works which were at least as high as the wages paid to skilled labor. Again, as a society, we are seeking to establish standards for the proper compensation of engineers in the employ of public and private corporations.

However, so definite have become the demands for more effective action and more tangible results that quasi-technical organizations have been formed which have as their primary objective the improvement of the economic status of the engineer. Guilds and other associations are in existence for similar purposes, which make no pretense of being technical in character, and in some localities the younger engineers and engineering aides have gone so far as to join militant labor organizations.

It should be obvious that this trend towards trade unionism, if permitted to continue, will destroy whatever standing the engineer has obtained as a member of an acknowledged profession. Hence, it is imperative that we consider what line of action is available to us other than the direct action of collective bargaining.

An Obligation to Help Others.~It is evident to me that the answer lies in recognition of the responsibility of each engineer to his subordinates. I wish to emphasize that point. It means that most of the members of this Society must assume, actively and individually, the obligations of the dual function of employee-employer. Such a duty goes far beyond the administration of the work of engineers subordinate to him; it involves real concern for the working conditions of those subordinates and for the monetary and other rewards they receive for the work which they do.

With full appreciation of the altruism, ideals, and ethics of our profession, we must admit that the desire for money, with the power and security that money gives, is the controlling motive of modern civilization. Rightly or wrongly, the world today measures its recognition of the work of the individual by a money standard. Such being the situation, it is desirable and proper that each engineer should further the interests of every engineer subordinate to him by emphasizing to his superior or employer the importance of the engineering problem, the accuracy of execution, the responsibility, and the integrity of purpose that characterize the work of his subordinates.

A Challenge to the Profession.~Instead of accepting this responsibility as an individual, the engineer generally has shifted it to some organization with the hope that something would be done. When he did so, and failed to sell to his superiors the value of the services of his subordinates, he failed also in his obligation to the profession. Improvement in the social and economic status of the members of the engineering profession can come as a result of our own individual efforts, if every engineer will acknowledge the responsibility of the employee-employer relation which is peculiar to the engineering profession, if also he will accept the obligation of this relationship, and finally, if he will make that obligation the basis of his own professional action.

Failure to accept that obligation will jeopardize the professional standing of engineers and engineering, because any further trend towards trade unionism among engineers will destroy public confidence in us as members of a true profession. By our own efforts we can correct the conditions which already have forced many engineers to put aside the standards of the profession and accept those of a trade instead; but effective action may not be postponed, and the responsibility rests directly upon the individual members of the American Society of Civil Engineers.

Louis C. Hill
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Volume 7

CIVIL ENGINEERING

September 1937

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Number 9

Closing the Fort Peck Dam

Critical Operation, Long in Preparation, Successfully Effected on June 24, 1937

By T. B. Larkin
Member American Society of Civil Engineers
Lieutenant Colonel, Corps of Engineers, U. S. Army; District Engineer, Fort Peck District, Fort Peck, Mont.

Every large undertaking involves some particularly delicate or crucial operation that may spell success or delay, possibly failure. In the case of the Fort Peck Dam, this important feature was the closure of the main dam, throwing the river flow through the mammoth diversion tunnels. All preparations for the previous four years were directed toward this event: all plans for the succeeding completion hinged upon it. Closure was the focus of the entire work, the key to successful accomplishment. Even with such complete preparation, so well described here by Colonel Larkin, fate intervened in the form of an unexpected and dangerous slide, threatening a vital railroad artery. By advancing the date already fixed and shifting the point of attack to the downstream instead of the upstream toe, closure was successfully effected on June 24. Previous articles in the September 1934, July 1936, and October 1936 issues have given detailed information concerning the engineering and construction aspects of the undertaking. Readers should study those articles before they attempt to assimilate the present one, in order that they may more fully appreciate the significance of the important events in the history of the project, related here.

FROM the inception of the work on the Fort Peck Dam, in the fall of 1933, it was appreciated that the closure of the river, with the attendant diversion of the Missouri through the tunnels, would be the climax of the job. It was also realized that the timing of operations was highly essential if progress was to be smooth and uninterrupted. This timing was particularly vital in connection with the construction of the diversion tunnels and the building of the dam.

Until the four 24-ft 8-in. tunnels (Fig. 1) could receive the river it was necessary to leave an 800-ft opening in the middle of the dam, building up the fill on the flood plain on each side. When work on the tunnels commenced in May 1934, their completion date was set for the summer of 1937, but with the reservation that possibly completion might not be effected in sufficient time to make the closure until 1938. However, as pumping of the fill proceeded and the production of the dredges far exceeded that for which they were designed, it became apparent from an analysis of foundation loading at peak points, an analysis of the foundation, and a study of the constricted river channel, that the fills on either side of the dam would rise to unsafe heights if closure were delayed beyond 1937. Accordingly, to accelerate progress, the tunnels were redesigned so that the entire lining could be placed in one operation rather than in two parts as originally contemplated.

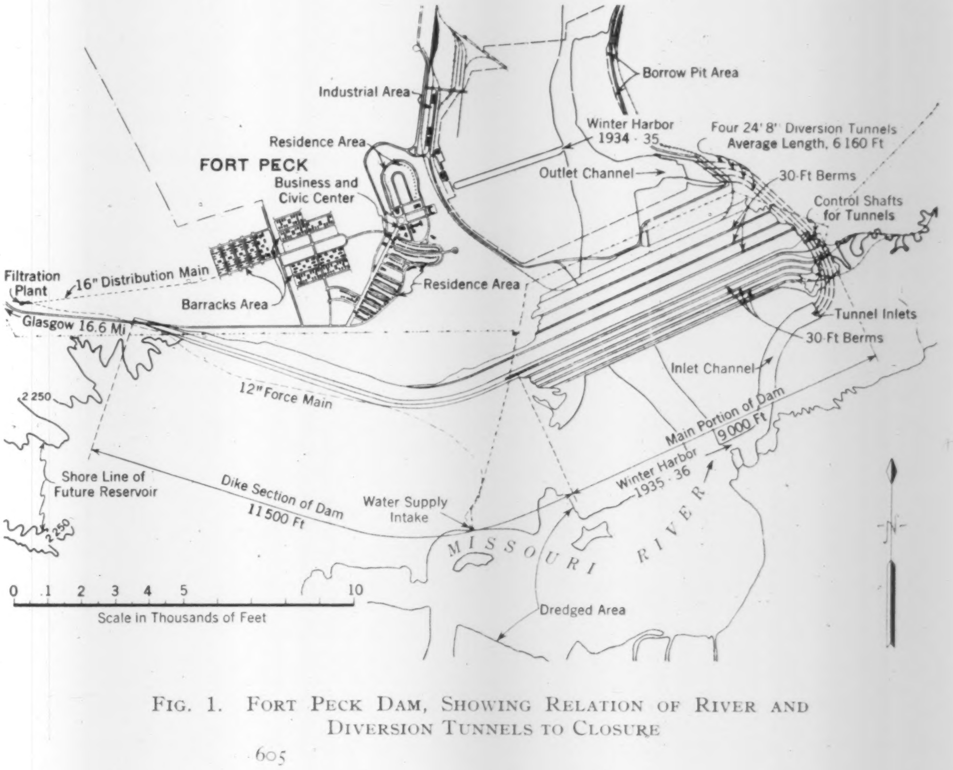
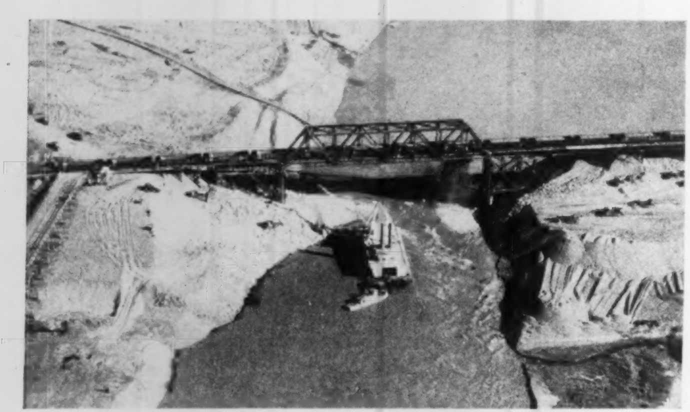

Borrow Pit Area
Industrial Area
Winter Harbor 1934 - 35
Four 24' 8" Diversion Tunnels Average Length, 6 160 Ft
Residence Area
FORT PECK
Business and Civic Center
Outlet Channel
30 Ft Berms
Control Shafts for Tunnels
Filtration Plant
16" Distribution Main
Residence Area
Barracks Area
Glasgow 16.6 Mi
Tunnel Inlets
30 Ft Berms
Inlet Channel
2 250
12" Force Main
Main Portion of Dam 9 000 Ft
Shore Line of Future Reservoir
Dike Section of Dam 11 500 Ft
Water Supply Intake
Winter Harbor 1935 - 36
MISSOURI RIVER
2 250
0 1 2 3 4 5 10
Scale in Thousands of Feet
Dredged Area
N

Fig. 1. Fort Peck Dam, Showing Relation of River and Diversion Tunnels to Closure

By July 1936, there was no longer any doubt that the tunnels would be ready to take the flow of the river in the summer of 1937, and the essential preparatory measures for closure were initiated. Plans were carefully formulated covering all phases of the operation; and every item of the work that could be performed prior to the actual period of closure was prosecuted. It was vital that the closure, once started, be carried through with the utmost dispatch, not only to cut down the lost dredging time to a minimum, but also to insure an immediate start on pumping fill into the closure section. With the river diverted, every cubic yard of fill placed in the closure section would increase the factor of safety against a possible flood stage.



CLOSURE OPERATIONS, LOOKING SOUTH (UPSTREAM)
Gravel Is Being Dumped from Railroad Bridge While Bulldozers Push Material Into Channel from Both Sides. View at 5:30 p.m., When Closure Was Approximately 75 Per Cent Accomplished

PREPARATORY OPERATIONS

Channels 200 ft in width leading from the inlet and outlet portals of the tunnels to the river (Fig. 1) had to be excavated. A considerable amount of earth was involved inasmuch as the inlet channel is one mile long and the outlet channel nearly one-half mile. Much of the material was suitable for fill and therefore could be pumped into the dam. A large part of the inlet channel was dredged out in 1935 and used as a harbor for all floating plant during the winters of 1935-1936 and 1936-1937. After the regular 1936 dredging season ended, a further portion was removed and pumped into the downstream berm. At the outlet channel some dredging was performed early in the 1937 season. Dry-land excavation methods, using shovels and trucks, were employed at both portals to remove any material containing shale, which could not be dredged. By June 1, 1937, both channels were ready, with the exception of relatively small "plugs" which separated the river from its future passageway around the dam through the diversion tunnels.

Another preparatory item on which work had to be started considerably in advance of the actual closure was the completion of the upstream railway trestle. This trestle was completed in May 1937. To provide a passage through which the dredges and attendant floating plant could be moved from above to below the dam, steel girders were salvaged from the downstream Missouri River bridge, thus giving a span with 46 ft in the clear.

Up to the time of closure, practically all dredging was from the upstream borrow pits. The excellent material existing upstream would of course become unattainable as soon as closure work started because obviously all dredges had to be moved downstream ahead of actual closure to avoid being land-locked. Furthermore, owing to the increase in the depth of the water, their suction pipes would have been unable to reach the necessary depth. Sufficient borings were made in the downstream borrow pits during 1936 and the early spring of 1937 to determine the areas in which the dredges would operate after the closure. This having been done, pipe-line locations were staked, and in the winter of 1936-1937 the pipe-line trestles were constructed.

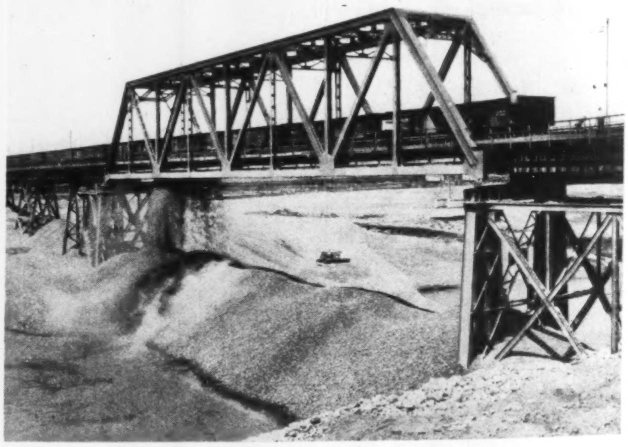
Accordingly, the only work remaining at the time of closure, as far as the pipe-lines were concerned, was the actual transfer of the pipes from their old upstream positions to the new downstream borrow-pit areas. An idea of the planning and work involved in this feature alone may be obtained from the fact that for the four dredging units there is over 110,000 ft of pipe line.

PROVISIONS MADE FOR MOVING VARIOUS MATERIALS

During the period prior to closure, when the fill was being built in two sections, one on each side of the channel, the dredge effluent was discharged back into the river by means of cascade spillways. Many plans were considered and thoroughly studied, and it was finally decided that the most positive and economical method of disposing of the dredge effluent after closure was to use pumps mounted on barges. Four pump barges were constructed, each provided with one centrifugal, electrically operated pump. These pumps were some that were no longer suitable for dredging use but were still serviceable for handling the dredge effluent.

Considerable timber, mostly cottonwoods, exists in the valley of the Missouri upstream from the dam. It was considered essential to do a reasonable amount of clearing to prevent an excessive amount of trash from gathering in the river pool. Work was actively pushed on this clearing during the winters of both 1935-1936 and 1936-1937.

A layer of undesirable clay and vegetable matter on top of the underlying sand had to be removed from the closure section as had previously been done for the remainder of the base of the dam. Some of this work it was possible to perform during the winter of 1936-1937 by means of common dry-land excavation methods; the remainder of this stripping was done by two of the effluent water-pump barges. By an ingenious arrangement the boats were lashed together, swing lines improvised, and the 28-in. streams reduced to 15 in.; thus a sort of a giant double monitor was secured. This proved to be



FILL ACROSS MAIN CHANNEL AT RAILROAD BRIDGE
View on June 25 at 10 a.m.; Closure Effected at 7:05 the Previous Evening

most effective and economical in removing all objectionable material.

LAYING PLANS FOR CLOSURE

With the exception of the stripping just described, all the preparatory operations had been carried out well in advance of any possible closure date. From a close study of the sequence and size of the essential operations such as plant movements, completion of channel excavations, and movement of dredge pipe, it was determined that the closure date had to be set at least 10 days ahead of the actual date on which the river was to be turned aside. The selection of the closure date was dependent on two important and vital factors: first, closure could not, of course, be effected until the tunnels were completed; and second, closure could not be safely made until danger of further high water, which normally occurs in May or June, had definitely passed. Also important in the selection of the closure date was the desirability of starting to pump fill into the closure section as early in the summer as possible, to preclude any possible overtopping during high water in the spring of 1938.

The plan adopted was to make closure at the upstream toe. A number of considerations influenced the decision to make the closure there rather than at the downstream toe. The use of boulders with gravel would permit a safe and easy closure, but the 200-ft through span of the downstream bridge was not designed, nor could it well be adapted, to permit the dumping of rock, whereas rock could be dumped from all parts of the upstream trestle.

On June 15, 1937, June 26 was designated as the date for the closure, and the construction forces immediately proceeded in accordance with the plans.

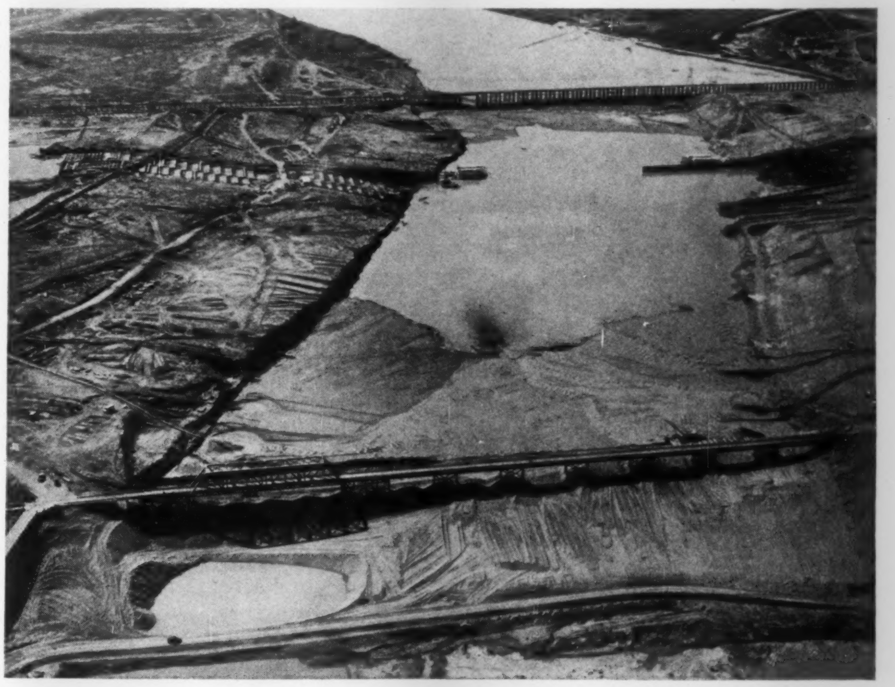
SOME PRELIMINARIES NECESSARY

At the inlet channel a dredge was promptly set to work and in two days reduced the plug to a 50-ft top width, wasting the material, which was unsuitable for the fill, into an adjacent coulee. This work having been completed, the dredge was moved downstream, her floating and land boosters having previously been towed to their new positions. A dredge was also immediately put into the outlet channel to remove the remaining 500-ft plug of earth which separated the tunnel outlet portals from the river.

In the meantime, the towboat *John Ordway*, assisted by seven 100-hp gasoline work boats, was moving the other two dredging units to their downstream berths. Pipe-line crews were vigorously pushing the dismantling of the old upstream lines and transferring the pipe to the trestles which had been built during the previous winter.

At the same time crews were everywhere at work carrying on the additional items connected with the closure. The pump boats were set in place, two on each side of the river, upstream from the steel sheet piling cut-off wall; snags and debris were removed from the channel; as much gravel was dumped both upstream and downstream as possible without dangerously constricting the channel; lower portions of the cascade spillways were removed so that they would be in the clear for placing the closure fill; log booms for stopping driftwood and trash were placed across the inlet channel.

To provide an additional safety factor against the head of the river water behind the plugs at both the inlet and outlet channels, low clay levees, commonly known on the lower Mississippi River as sub-levees, were built between the natural plugs and the tunnel openings. These sub-levees were filled to an elevation about halfway between the water surface in the river and the bottom of the excavation on the opposite side. As the closure date drew near, the top elevation of the natural inlet plug was reduced, first to 2,050, then to 2,047, then to 2,044. In the meantime the river stage was approximately 2,037.



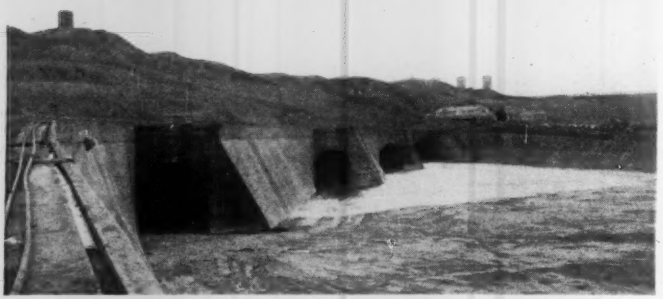
Air View of Channel Section from the North, Six Days After Closure

Beyond Railroad Bridge Is Receding Central Pool, with Pump Barges; Still Farther, Trestle Along South Toe Appears. From Upper Core Pool of East Fill (Left) Cascade Spillways Lead to Channel. Critical Slough That Upset Closure Plans Is Seen at Left of and Beyond Railroad Truss in Foreground

Up until June 23 all phases of the closure operations had proceeded smoothy and in accordance with plans, but on that date, at 3:00 p.m. an incident happened which required that the plans be radically altered.

At that time there occurred a movement of a section of the sand shell on the river side slope of the right downstream portion of the dam, just upstream of the main east pier of the through channel span. This earth movement, similar to those so frequently seen on the lower Missouri and Mississippi rivers, was caused by the rapid fall of the river after recent high water and by considerable scour due to the channel constriction at the downstream toe. It may be mentioned here that on June 15 the Missouri River carried about twice the amount it had ever carried since construction commenced in the fall of 1933. In addition, the channel through the dam had been constricted to less that a fifth of its original width.

This shifting of the sand shell threw a tremendous load against the east main bridge pier supporting the 200-ft through span of the Missouri River bridge, resulting in an 8-in. horizontal movement and the opening of a 6-in. crack in the concrete. Observations indicated that the crack was slowly widening. Immediate action was required to save the pier. Without delay 30 carloads (1,200 cu yd) of gravel were dumped on the river side of the pier, and this stopped further movement. Owing to the contraction of the channel by the gravel, the current increased, and thus some of the gravel was washed away.



THE MISSOURI EMERGES FROM DIVERSION TUNNELS
First Water Appears 29 Minutes After Diversion. Photograph Taken at 4:49 a.m., June 24, 1937

Additional carloads were dumped as needed to replace that removed.

The river continued to fall rapidly and further earth movements were probable. It was realized that if this occurred, the endangered pier would probably go out at once, thus creating a serious situation, since the bridge was the only artery for rail and vehicular traffic across the river. Furthermore, closure would be delayed. It may be interesting to note here the various precautions taken to insure closure, irrespective of what might happen. The rock and gravel used at Fort Peck are brought in by rail from Cole, Mont., 75 miles away. At this time of year cloudbursts are not uncommon and might readily cause a serious washout of the main line of the Great Northern Railway. To meet such a contingency, enough gravel and air-dump cars were always kept on hand at Fort Peck so that closure could be effected by utilizing the gravel and rock already placed on the upstream face of the dam. When the bridge pier cracked and the through span started to move, the closure plan was further modified by holding sufficient rock and gravel cars on the east side of the river. Had the through span gone out, a temporary pontoon bridge to handle all vehicular traffic would at once have been thrown across the river and closure would have proceeded as planned.

CLOSURE DATE ADVANCED

However it was decided, on the evening of June 23, after a check-up showed that the tunnels would be ready, to make closure on the next afternoon and to effect the closure at the downstream toe. Not only could closure be effected there more quickly than at the upstream toe, but also it would insure protection of the main bridge span and add a considerably increased counterweight of water to prevent further movements of the fill. At 1:00 a.m. on June 24 the tunnels were finished and cleared. Water was admitted to the tunnels at 4:20 a.m., and the plug at the outlet portals was broken at 7:00 a.m.

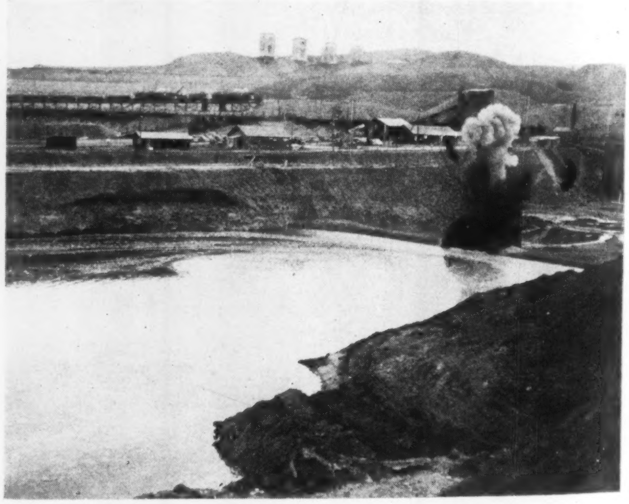
Since the single through span of the Missouri River bridge was not designed to permit the dumping of rock from its sides, boulders had to be dumped at the ends of the span before closure was commenced. To retain the gravel with which closure was to be made, a derrick boat, equipped with a 3-yd orangepeel bucket, was placed on the right bank just below the through span. During the day of the twenty-fourth and until closure started in the afternoon, the derrick boat placed a rock sill across the channel as far as it could reach. To push gravel and rock into the opening after closure started, a fleet of 13 large bulldozers was assembled, 9 on the left side and 4 on the right side of the channel. Preliminary to starting actual closure, all loaded rock cars (45) and 16 carloads of gravel were dumped at the ends of the span. No rock was dumped during the actual closure as the air-dump cars occasionally are hard to retract. Had this happened, serious delay would have resulted.

Meanwhile, the movement of gravel trains from the plant at Cole had been accelerated so that, when closure began, 380 carloads (15,200 cu yd) of gravel were at Fort Peck.

THE RIVER IS DAMMED

When closure commenced, at 4:51 p.m. on June 24, the flow through the tunnels had attained 2,400 cu ft per sec, while the total flow of the Missouri River was about 10,000 cu ft per sec. Trains of gravel were in cuts of 40 cars each, and the operation was so timed that, as soon as one train was unloaded, another followed immediately in the rear. At 7:05 p.m. the river (less storage) was going through the four diversion tunnels. In 2 hours and 14 minutes, 140 carloads of gravel had been dumped, completely closing the Missouri River. Pumping of fill into the closure section commenced at 9:20 p.m. the same evening and dumping of gravel and rock continued throughout the night to strengthen the closure.

As this is being written, six weeks after closure and diversion were effected, over 6,500,000 cu yd of fill has been placed in the closure section, bringing it to an average elevation of 80 ft above the original surface. Both gravel toes are up to final grade.



DIVERTING THE MISSOURI
Blast at 4:20 a.m. on June 24 Starts River Flow Toward Tunnels. Control Shafts Appear on Hill Beyond

It is expected that, by the time cold weather forces the cessation of dredging, the entire dam will be up to El. 2,180 or higher, giving a height of fill of approximately 150 ft. This will insure protection against any possible rise of the river.

The tunnels, as already stated, are complete with the exception of the main control gates, which will be placed in 1938. Spillway construction is 85 per cent complete and will be essentially finished by January 1, 1938. Nothing can be foreseen at this time which will prevent the completion of the entire project, with the possible exception of a small amount of riprap placement, by the late fall of 1938.

Rehabilitating the Dust Bowl

And Common-Sense Solutions for the Problems of Other Great Plains Drought Areas

By John E. Field
Member American Society of Civil Engineers
Consulting and Supervising Engineer, Denver, Colo.

Drought in the so-called "Dust Bowl" area of the Great Plains reached a one-hundred-year climax in the period 1931–1935, when a succession of dust-storms rendered hundreds of square miles of farming land apparently useless for agriculture. Some of the more arid parts of this region should never have been put under cultivation, but the soil is of good quality and produces well where irrigation is provided. Since there is a shortage of settlers on irrigated lands, movement of the "drylanders" to such areas is plainly indicated. The furnishing of supplemental water supplies to partially irrigated areas is also favored by Mr. Field, who shows that projects for land reclamation and for abandonment of dry or marginal farms are not inconsistent but mutually dependent. Turning next to agricultural problems in the Great Plains area as a whole, he recommends a return to grazing uses. An earlier article by Mr. Field on the Dust Bowl appeared in the September 1936 issue of the "Engineering Bulletin" of the Colorado Society of Engineers.

The Dust Bowl proper, as distinguished from the larger drought area of 1935 and 1936, is as large as New York State, and its geographical center is somewhat east and south of the point where Kansas, Oklahoma, and Colorado come together. From the Gulf to Canada, and between the ninety-eighth meridian and the Rocky Mountains (almost the north-and-south center line of the United States), lie the Great Plains, a semi-arid but well-sodded, gently sloping area of some 450,000 sq miles. Over it the buffalo passed northward in the spring and southward in the fall scattering the seeds of Gramma and Buffalo grass in the rich mulch of their droppings. When cattle came, they were kept in a comparatively narrow area where they cropped the unripe seed and wore deep trails to water. Then came the sheep, "cropping shorter the short green grass." And today, where in the days of the buffalo there was a heavy sod of strong, nutritious grass, one looks long for a single bunch of Buffalo grass. Instead of one continuous blanket of Gramma grass, there are only small tufts covering about half of the ground.

Consideration of a remedy for conditions in the Dust Bowl brings up the whole problem of the proper treatment of the Great Plains area, including reforestation, flood control, reclamation by irrigation, abandonment of marginal lands, resettlement, grazing, surplus crop production, and social and economic problems in general—also, perhaps, matters of preparedness and national defense.

The most prevalent error in connection with the general problem is the opinion, often expressed, that it is inconsistent to reclaim land for farming on the one hand and abandon farmed lands on the other. This opinion prevails not only in the eastern half of the United States, where little is known of land reclamation, but in the irrigated districts as well, where such lack of understanding is as astounding as it is distressing. It is incomprehensible that so fallacious a view should be widespread in a region dependent on irrigation for its continued growth and prosperity—in fact, for its very existence.

The immediate cause of the dust storms is the extreme dryness in almost all the years from 1925 to date. Overgrazed lands, unable to retard and so to absorb the rainfall, produce floods; the land loses its moisture to a great depth; and vegetation languishes. Between 1914 and 1920 many areas were plowed and cropped as a war measure, and by tenderfeet who did not know the West. With the passing of the demand for grain and the consequent reduction in prices, much of this land was abandoned, and grass, weeds, and even Russian thistle failed to grow, with less than normal rainfall.

During the dry period 1901–1905, I saw cactus that was dead and brittle and areas of almost no grass where I was told that hay had formerly been cut. To the uninitiated this would have seemed just another of those tall Western yarns; yet in 1907 I saw hay being cut on some of that same land.

USE CHANGES IN THE GREAT PLAINS

Let us review the development of uses in the Great Plains. The cattleman took over the pastures of the buffalo, and later the sheepman insisted on sharing them with him. After the sheepman came the homesteader, encouraged by unwise laws and privileges, trying first to farm and then to raise stock—aggravating the overgrazing problem. Depredations by settlers and cattle barons were common, each striving to run the other off the range. Many a settler survived only because a lamb or a calf could be had "by the light of the moon," while the cattlemen deliberately overgrazed the pastures adjacent to settlers' holdings so as to force them to "git out." Both attempted to acquire the strategic water holes by lawful or unlawful means, and Uncle Sam ordered all drift fences removed. The cattleman, harassed as he was by homesteaders, by foresters with a theory, and by ever new and more numerous regulations promulgated by legislatures and departments both state and national, had neither the opportunity nor the incentive to evolve a sane and proper policy of land use. Is it any wonder

A Pioneer Family of Today on the Vale Federal Reclamation Project in Eastern Oregon

This World War Veteran Purchased the Equipment Shown Here, Seed, and a Team of Horses. He Has Every Prospect of a Permanent Home in the Near Future on His Forty Acres of Sage Brush Land to Which the Government Canal Has Been Extended

Scrubby Sage Brush Indicates That the Land Is Fertile but Tough, Requiring the Addition of Humus—View in 1911

Orchard Land Here Is Now Worth an Average of $2,000 an Acre, Exclusive of Buildings—View in 1920

GRAND VALLEY, COLORADO, BEFORE AND AFTER CONSTRUCTION OF IRRIGATION SYSTEM BY BUREAU OF RECLAMATION

then, that he was at times a "bad hombre" and neglected to conserve the range which was so rapidly passing out of his hands.

SOILS UNLIKE THOSE IN EASTERN UNITED STATES

Turning now to the problems of the homesteaders, it should be noted that the soils of the Great Plains are quite different from those in the eastern half of the United States. They are a sandy loam, varying from very heavy adobe to very light sand almost devoid of clay. Throughout their depth to bedrock they are rich in mineral plant food, and when exposed to sun, air, and rain they rapidly assume the qualities of top soil. In the Atlantic States the shallow top soil is underlain by clay, an inert material devoid of the needed soluble minerals. The soils of the arid region, formed almost wholly by disintegration and laid down in the absence of water, are in an unstable chemical form and unleached of their soluble minerals. When water is applied artificially, disintegration is tremendously accelerated and the mineral content necessary to plant growth is constantly replenished.

In the great plains area the use of commercial fertilizers is all but unknown. To be sure some stable manure is spread, but more for the purpose of making the heavy adobe soils lighter and the light sandy soils heavier than for its fertilizing value. According to the U. S. census, in 1929 the consumption of commercial fertilizer in Colorado was 1,150 tons as compared to 348,000 tons in Pennsylvania. In the highly cultivated areas, especially in the potato and sugar-beet districts, alfalfa is turned under about once every ten years. This adds humus and nitrogen to the soil and results in an average yield of 15 tons of beets and 200 sacks (400 bu) of potatoes to the acre. That 15 tons of beets, by the way, produces 4,500 lb of sugar. Also, the by-products of an acre of beets (tops, pulp, and molasses) have a feeding value equal to an average acre of corn.

I mention these seemingly extraneous details to emphasize the fact that even though all the top soil were eroded or blown away, the Plains area could be brought back into satisfactory production in a few years. Although the wind-swept earth looks hard, slick, and inert, or is piled high in dunes, it will grow grass almost as luxuriant as the lost top soil if it can be held until the grass starts.

Somewhat lurid accounts of dust bowls, droughts, starving cattle, federal relief, and floods have dominated the news from the Great Plains country for the last few years. Unless it was in the grasshopper decade of the 1870's, this region has never before been so unfavorably publicized. This publicity, accentuated by photographs and radio reports, has produced a condition of hysteria which is not entirely justified. Government aid is demanded, in part because almost everyone, whether he be banker or laborer, looks to Uncle Sam for succor and relief from the results of his own mistakes and follies. But the folly of farming the Great Plains was not wholly that of the settlers, for in spite of the warnings of old timers, Uncle Sam encouraged settlement by offering increasingly liberal terms to homesteaders and imposing increasing restrictions on the already harassed cattlemen and on the grazing industry. The present aid extended to the drought area is in part an act of justice in mitigation of the error committed in encouraging settlement of this part of the Great Plains.

RESETTLEMENT AND IRRIGATION ACTIVITIES RECONCILED

Although, as previously stated, it seems inconsistent to many to abandon farms on the one hand and reclaim land to make more farms on the other, this inconsistency is only apparent. Railroads, for example, abandon unproductive lines and improve or build others that will pay better. Similarly the individual farmer will turn his less remunerative land into pasture and break up a new piece of better land. But the problem is not fully answered, where extensive changes are involved, without a consideration of surplus crops. Table I, taken from actual experience in Colorado in 1936, illustrates the effect of abandoning some lands and reclaiming others.

In this table the price per ton of alfalfa is perhaps $1 higher than the average, and the price of potatoes 25 cents per bu higher than the average. But it will be noted that the value of the by-products of sugar beets is not shown. This would amount to about $400, or more than any excess in the total value occasioned by too high a unit value for alfalfa and potatoes.

Let us consider what would happen if the 160 acres of non-irrigated land in Farm C were converted to pasture, and if the irrigated land now having water only to June 15 (Farm B) were furnished with a full supply. Let us further assume that half of Farm B is purchased by the owner of Farm C. The value of Farm C when converted to pasture would be about $40 per year. All the crops raised on it, including 154 bu of corn, 100 bu of barley, and 300 bu of wheat, would be eliminated from the market. But the produce from Farm B would with a full water supply be the same as that from Farm A. This means a decrease of 1,200 bu of wheat, a surplus crop, and an increase in the non-surplus crops of alfalfa, vegetables, sugar beets, and potatoes.

Taking into account the grain formerly raised on the abandoned land, a total decrease of 1,754 bu of surplus crops would result. At the same time the combined earnings of the two farmers, B and C, would rise from $4,203 to $10,271. Farmers B and C would each receive about $5,135. This represents a gain of nearly $2,000 for Farmer B and a gain of $4,123 for the dry-lander. Whatever the latter paid the former for his half of Farm B would be available to pay off the mortgage on Farm B. Incidentally, the purchasing power of the two would be increased two and one-half times, and their standard of living would be raised.

TABLE I. CROP INCOME ON THREE TYPICAL NORTHERN COLORADO FARMS OF EQUAL ACREAGE

On the Basis of Ten-Year Average Yields; Unit Prices as of December 15, 1936

CROP	ACRES	YIELD PER ACRE	UNIT PRICE	VALUE PER ACRE
FARM A. IRRIGATED—FULL WATER RIGHTS				
Alfalfa	60	3.5 tons	$ 9.10	$ 1,911
Oats	20	45.0 bu	.49	441
Vegetables	20	.....	100.00	2,000
Irrigated pasture	20	.....	3.00	60
Sugar beets	20	16.0 tons	5.81	1,859
Potatoes	20	200.0 bu	1.00	4,000
Total	160			$10,271
FARM B. IRRIGATED—WATER TO JUNE 15				
Alfalfa	40	2.0 tons	$ 9.10	$ 728
Wheat	40	30.0 bu	1.08	1,296
Oats	40	45.0 bu	.49	882
Vegetables	5	.....	50.00	250
Idle or pasture	35	.....	1.00	35
Total	160			$ 3,191
FARM C. NON-IRRIGATED				
Corn	20	7.7 bu	1.05	$ 162
Beans	20	254.0 lb	.045	229
Barley	10	10.0 bu	.74	74
Sorghum	20	10.6 bu	1.75	208
Wheat	30	10.0 bu	1.08	324
Idle or fallow	60	.....	.25	15
Total	160			$ 1,012

If this general scheme were followed, there would be increases in the production of sugar beets and potatoes. But sugar is non-competitive, and potatoes in most years are a non-surplus crop. There is never a surplus in alfalfa, some of which will go into stock cattle and into fattening lambs and cattle, and some into dairy cows. Some will also be shipped to Missouri Valley dairies as alfalfa meal, and in the final cycle of trade it will pay for the corn needed to fatten the lambs and cattle on the irrigated farm, where alfalfa, oats, beet-top pulp, and molasses are fed. The cattle and sheep are fattened during the fall and winter and sold in February, at a time when there are almost no "killers" reaching the packing plant from other sections. This fact materially affects the price of beef and mutton, for Colorado produces on the average 25 per cent of all fat lambs and 11 per cent of all fat cattle reaching the packing plants in a year. In 1930 the percentage of lambs reached the remarkable peak of 38 per cent. These records have been made possible by using the by-products of the beet-sugar industry. It is apparent that if the number of beeves and lambs sold is increased, the price of meat will be reduced accordingly, and the meat bill of the whole United States will be affected. This fully justifies the production of sugar beets on an increased scale.

A COMMON-SENSE SOLUTION

But even though such redistribution of acreage as outlined may prove 100 per cent successful, what, it may be asked, is the settler in the drought area to do during the uncertain years of recovery? He is going to do just what he did in previous periods of drought—he is going to move, with or without the aid of the Resettlement Administration.

In previous droughts (such as that of 1892–1902) the dry-landers either hoped and suffered, or moved to other employment and to other localities. Those in eastern Colorado and adjacent areas moved to lands served by irrigation canals, or they moved back into Iowa and Missouri, to live with, and often on, the old folks at home. In 1893, I read the following on the door of a homesteader's shack in the rain-belt area of Colorado:

> "God bless our little home.
> We have negotiated a loan
> And gone back to live with our wife's people."

Uncle Sam is to some extent pinch-hitting for the farm-loan companies of yesteryear.

Two personal experiences will illustrate my theory of the proper treatment of the resettlement and rehabilitation problem in the Dust-Bowl areas. In 1893, a sorry-looking outfit consisting of parents and six children drove

HOMESTEADING ON THE VALE FEDERAL RECLAMATION PROJECT IN EASTERN OREGON

The Series of Drops in the Canal Is Typical of Almost All Projects

A TYPICAL LINED SIDE-HILL CANAL ON THE YAKIMA PROJECT, WASHINGTON

Lining Prevents Leakage, Breaks, and Washouts up to our ranch (that is what we called it although it was an irrigated farm) and asked for work. The following winter, this family became tenants on a crop-share basis. They remained for ten years, and when the farm was sold in 1904 they found they could buy a place of their own. Their daughters and one son were married and there were several grandchildren; some of the family had gone into the coal mines near by; some were farming; one was teaching; and one was a ne'er-do-well. In other words, it was a typical American family, rehabilitated in a period of serious depression and drought similar to the present.

SUGAR BEETS RAISED ON NORTH PLATTE IRRIGATION PROJECT

Area Was in Short Grass in 1907

In 1895, a German with ten children answered an advertisement for an experienced gardener for a 20-acre garden tract. He was a starved-out drylander or "rain-belter." He too stayed some ten years, on a cash-rental basis. He left me to buy a 160-acre farm in eastern Kansas and has since done well. In both these cases, the old folks gave the children an education through high school.

The best cure for the ills of the present-day Dust-Bowl and dry-land farmer is to put him on land served by an irrigation canal and tell him to "root, hog, or die." Continued wet-nursing by national, state, local, or individual charity should be eliminated as rapidly as possible and should cease when he is placed on irrigated land. He can then secure enough work locally to buy food, provided too many of him are not placed in one community. The real question then is: "Is this man willing to work hard and limit himself to the necessities of life in order to raise and educate his children and have a competence for himself and his wife at the end of twenty years?"

MORE SETTLERS NEEDED ON IRRIGATED LANDS

It may be asked whether there is enough irrigated land now available to meet these people's needs. That there is much such land needing settlers is easily shown. From a rather intimate knowledge of irrigation projects in their inception, development, and final maturity, I assert that lack of rapid, competent settlement has been the major cause of the delayed economic success of many projects. I use the word "competent" advisedly, for on many projects inexperienced, slothful, or speculative settlers were found to be almost as bad as none at all.

There is scarcely an irrigated district where the cultivated area cannot be increased, or where, with more permanent and dependable labor, bigger and more valuable crops cannot be grown. The seasonal importation of labor to meet the peak demand has not been satisfactory, and in the case of alien labor, conversion into tenants or owners has led to deterioration in the quality of the products and to a striving for mere tonnage. The need for more native tenants and owner-operators is so apparent, and such favorable terms of rental or purchase can now be obtained from the overworked and often land-poor owners, that there will be no difficulty in finding room for the burned-out "Dust-Bowlers."

Resettlement efforts should be limited to supplying needed farmers to existing projects. Efforts to reclaim new land to be farmed by inexperienced men, who must find means of existence for the period of five years or more necessary to development, will result in failure. When the tenderfoot is placed on a project already well developed, where the pioneer years have passed, he will find neighbors to help and advise him. By precept and example they will educate him, and he will have a much better chance of success. Putting a large number of families on the same project or in the same locality should be avoided. Not more than 20 per cent of tenderfeet should be placed on a project.

SUPPLEMENTAL WATER SUPPLIES NEEDED

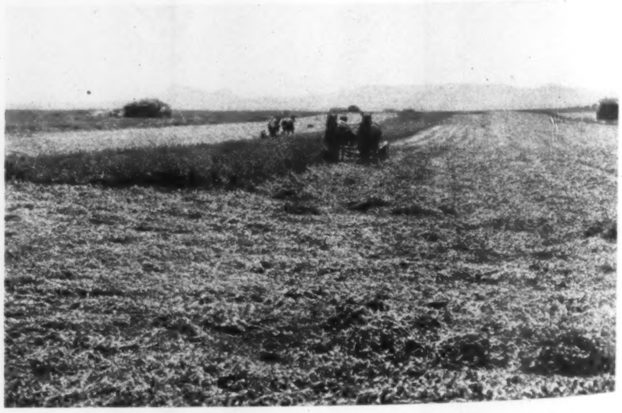
The land and opportunities now available can be greatly increased by the acquisition of supplemental water supplies. On many, and perhaps on most projects, there is either an insufficient water supply or the supply is inopportune, that is, the curves of supply and necessity are not coincident. These deficiencies can be corrected by the building of storage reservoirs.

The basic idea which finally culminated in the passage of the Reclamation Act of June 1902 was to furnish such supplemental supplies to existing projects. Both the Bureau of Reclamation and PWA are now aiding in the development of such supplies, and where federal aid is not available the irrigation companies are exerting themselves to improve their systems. The departure from that basic idea and the reclamation of new lands at an uneconomically high cost has not always been wise.

If, instead of extending the irrigated area, the farmer with a scant supply of water is given an adequate supply, there will be greater latitude in the selection of crops. Different crops need irrigation water at different times and in varying quantities, and the selection of what to grow is determined largely by the time when the water is available as well as by the amount.

With an ample and controlled water supply, more labor will be needed, and it will be less seasonal and more uniform throughout the year. The tendency then will be towards smaller farm units and towards ownership rather than share-cropping.

Shortage of settlers on irrigated lands has been due in part to inadequate water supplies and in part to the influences that diverted farmers seeking homes in the West from irrigated to dry areas. If these people had settled on land served by the then-existing canals, and if in 1920 the returning soldiers had been directed to irrigation districts instead of to dry public lands, much distress and discouragement would have been avoided. At the same time the irrigation districts would have received much-needed colonists.



MOWING ALFALFA ON THE NORTH PLATTE PROJECT

Land Produces Three Crops per Year Plus Good Fall Pasturage

The conclusion is that there is much irrigated land available, and the furnishing of supplemental water will increase the demand for farmers. Perhaps more important, and certainly more surprising, is the fact that reclamation, resettlement, conservation, and abandonment of marginal lands are mutually dependent; each is necessary to the other.

A RETURN TO EARLIER USES FOR THE GREAT PLAINS

When the question of the abandonment of marginal lands and the reclamation and improvement of other lands has been settled, the question of the proper treatment of the Dust Bowl and the Great Plains, from which most of the settlers have been moved, must be taken up.

It is obvious to all that it is necessary to change the manner of use of the Great Plains area. This will have the effect of reducing the population of the region, but will stabilize its productive value. In my judgment, this change will be largely a return to the conditions of the later 1870's, when cattle had taken over the range of the buffalo.

If these conditions had continued, the government, instead of encouraging farming, would have been called upon to regulate the rivalries and avarices of the stockmen. Inevitably there would have emerged a type of regulation of the public lands similar to that established by the Forest Bureau for the national forests. The regulations would have limited the size of the herds and would have required seasonal reseeding and preservation of the valuable grasses. Two major divisions of use would have been established—one for the winter range and one for the summer range. This would have resulted in a shifting of the herds, similar to the shift made by the buffalo in their migrations in the spring and fall. Similar migratory movements are made by sheepmen and cattlemen today in the use of the national forests.

The re-acquisition of unfarmable areas by the government is essential to regulation and renewed productivity and is a necessary part of the commendable effort being made to recapture the public domain.

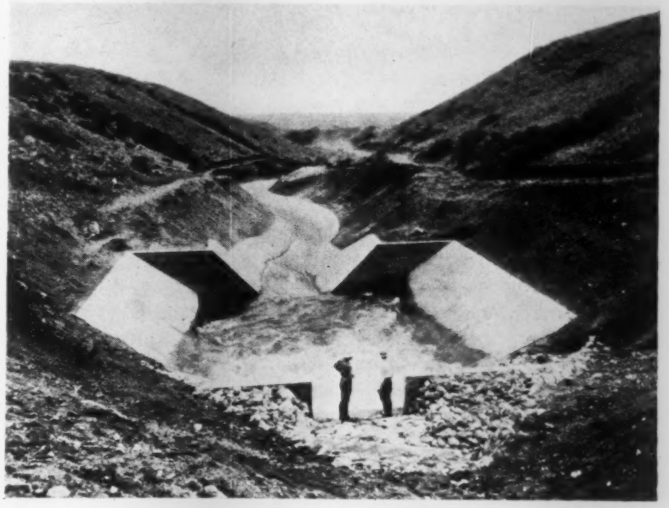
THE DUST BOWL CAN BE RESODDED

Assuming a cessation of abuses from overgrazing in the period of sod recovery (years of average or above average rainfall), the ubiquitous Russian thistle will first cover the ground with a verdant, soft, and velvety growth early in the season. If there is little rain later in the season this becomes a harsh, annoying plant, or if moisture is plentiful, an impenetrable thicket. Among these thistles, the grass begins to grow, protected from sun and wind and from too heavy pasturing. Such is nature's remedy, a remedy which, depending on the measure of encouragement man affords, can be made more effective and more rapid, or less effective and slower.

I once fenced in a dry-land golf links almost as bare of grass as the Dust Bowl. In one year, fortunately one of good rains, the Gramma grass sod became as thick and thrifty as ever buffalo grazed over, and now a few choice milch cows keep the grass not too long, and the "rough" not too rough, for the temperamental golfer. However, where nature is unaided, recovery may require twenty years.

The present disastrous weather conditions have accentuated the necessity of a return to a more primitive use for the Great Plains area. It is to be hoped that with the return of a cycle of wet years this movement will not be abandoned, but will be prosecuted with unremitting diligence, for it is in the wet years that resodding will be most rapid under wise and vigilant regulation. The amount of benefit secured will depend on whether the work is put in the hands of impulsive, well-intentioned, but inexperienced men, or in the hands of those who have both experience and good judgment. By experienced men is meant those who have passed through at least one period of drought and one period of recovery.

Patience and persistence are the two essentials in the effort to help nature. It will be necessary to wait patiently for a series of years with above-normal rainfall. The program would be to secure a supply of native grass seed to be sown in the spring when there had been abundant snow or rain and the soil was wet. Bare areas should be lightly disked, the seed planted, and the surface rolled. If rain came, followed by winter snows and spring rains, there would be a new grassed area. If nature did not cooperate in this way, it would be necessary to wait patiently for another wet spring and repeat the process until there was sufficient precipitation after planting to ensure the formation of a heavy sod.



Lower Outlet of a Siphon—Water from Western Slope of Continental Divide on Way to Denver

After Use by the City, 85 Per Cent Will Be Returned to South Platte River as Supplementary Supply for Irrigation, to Permit Growing of Late-Maturing and More Valuable Crops

As different conditions will require different treatment and different rules in the various states, the movement should be sponsored by the states in cooperation with the government. The states can well afford to aid financially, and they should have the major voice in fixing local regulations and treatment. All-federal control would tend to an unwise and impracticable uniformity in rules and regulations. Dual and cooperative control will lead to practices better adapted to local conditions.

In the past, droughts have given a stimulus to the development of irrigation projects, and floods have encouraged the construction of reservoirs for flood protection and for the conservation of water. Great good to the arid region has resulted in this acceleration of proper development. The menace of soil erosion by wind and water and the need for conserving all natural resources have been forced on the public conscience. As in the past, the current distress will eliminate the thriftless and relocate the misplaced and inadaptable. However, in the past there has always been a new crop of the unwise to rush in when the cycle of plentiful rainfall returned. It is to be hoped that the government will not again encourage this movement, and that the ignorant will not again be permitted to attempt to farm the pasture lands of the West.

Determination of Bond Maturities

Formulas and Curves That Can Be Used for Many Problems

By ALLAN T. RICKETTS
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AT intervals the engineer must turn accountant and delve into the intricacies of bond retirement. Mr. Ricketts here presents a succinct review of the principal problems arising in this field; he provides a chart which permits rapid solutions to a reasonable degree of accuracy, as well as formulas which can be used for precise results. The young engineer with a limited knowledge of securities will glean much practical and fundamental information from this article, and many older engineers as well will find it a valuable reference article to clip for their notebooks or files.

THE determination of bond maturities is a problem that the engineer is frequently required to solve. In many cases published financial tables are of little value and the cut-and-try method is generally used. There are certain conditions, however, that can be solved mathematically, and the formulas and curves here presented have been developed for the solution of such problems. The formulas give precise results, but the curves will give solutions sufficiently accurate for the purpose of engineering studies.

In the present discussion, the following definitions will apply:

Serial bonds: Bonds or blocks of bonds, some of which are due periodically, usually each year during the life of the loan.

Term bonds: Bonds or blocks of bonds that are due at the termination of the loan period.

Sinking fund: An amount accumulated by setting aside periodically, usually each year, a fixed amount which, at maturity with interest accumulations, will be equal in amount to the bonds due.

Maturity: Termination of the period of the loan; also used to define the due date of each bond.

Amortization: Repayment of loan.

Debt service: Annual interest and principal payments; the latter may be for serial bond cancellation or sinking fund.

Amount available: Amount that can be used to meet the debt service; usually, the balance after deducting expenses of operation and maintenance (also taxes, insurance, and depreciation, if applicable) from gross revenue.

Bonds are classified as serial or term, depending upon the method of repayment. It is this feature of the bond issue that affects the economics of the project, and with which the engineer is directly concerned. If term bonds are used, a sinking fund is usually set up to meet interest payments and principal on the due dates. The total cost of securing money is greater under this method of repayment than under the serial method, because the rate of interest received from a sinking fund is usually less than that to be paid on the bonds for which it is created. This, together with the fact that under the serial method of repayment, the principal is gradually reduced more in keeping with the depreciated physical value of the property, has resulted in the increasing use of serial bonds.

USE OF FORMULAS AND CURVES FOR SERIAL BONDS

It is obvious that formulas apply only if the amount available and the amortization conform to a constant law. The formulas of Table I are developed primarily

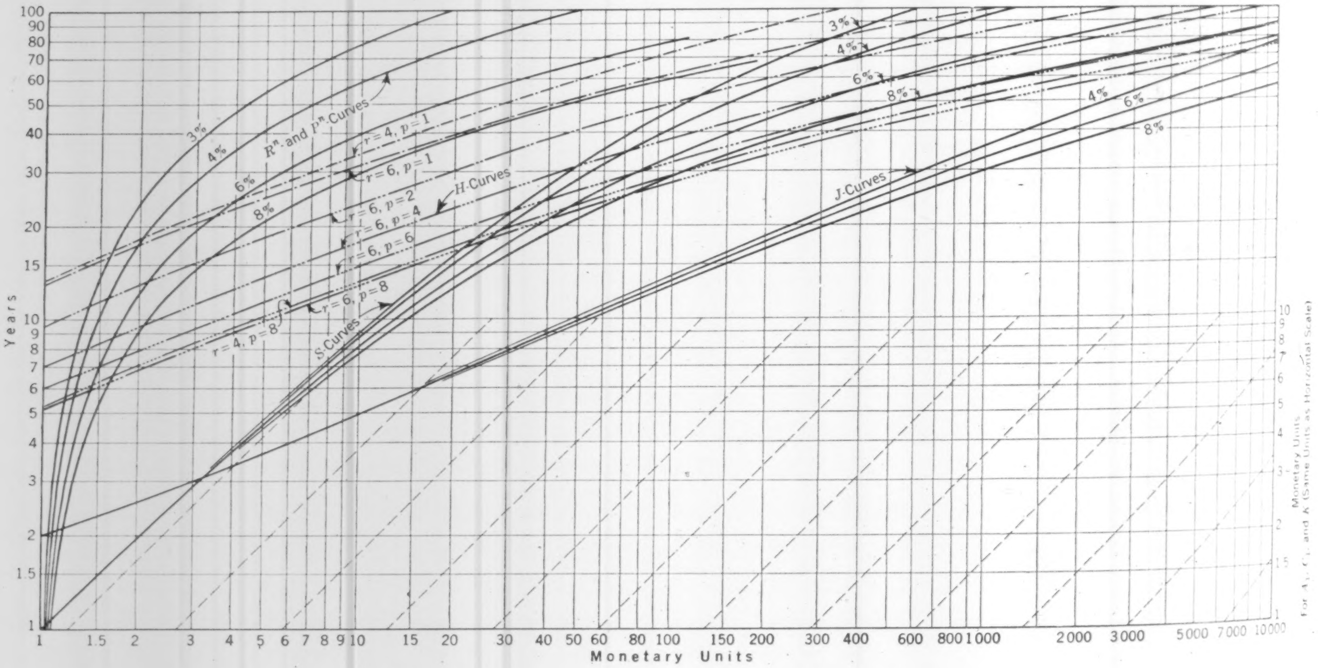

FIG. 1. CURVES FOR SOLVING PROBLEMS IN BOND MATURITIES

for serial bonds, but Formula 4, with some slight modifications, and the curves of Fig. 1 as well, may be used to determine the amount of sinking funds for term bond issues.

Conditions most usually met with in serial bond issues may be classified as follows, depending upon the law to which the "amount available" conforms: (I) Amount available uniform during the life of the loan; (II) increases annually by a uniform amount; (III) increases annually by a uniform percentage; and (IV) decreases annually by the amount of decrease in interest payments (that is, when amortization is uniform).

Case IV is comparatively simple. It will not be discussed in the present article, and the formulas applicable to it have been omitted from both the table and the figure. Table I is self-explanatory. It should be noted, however, that the formulas have been developed so that most of the factors, particularly those involving functions of the rate of interest or percentage of increase, can be evaluated directly from any complete compilation of financial tables. Approximate solutions can be obtained with any slide rule and quite readily with a log-log rule.

To illustrate the use of the curves, the following solutions of typical problems are given. The nomenclature is explained at the end of this article.

Case I, Problem 1. Given a 6 per cent bond issue of $500,000, to be retired by an annual payment of $36,250. To find the period of the loan and the total debt service.

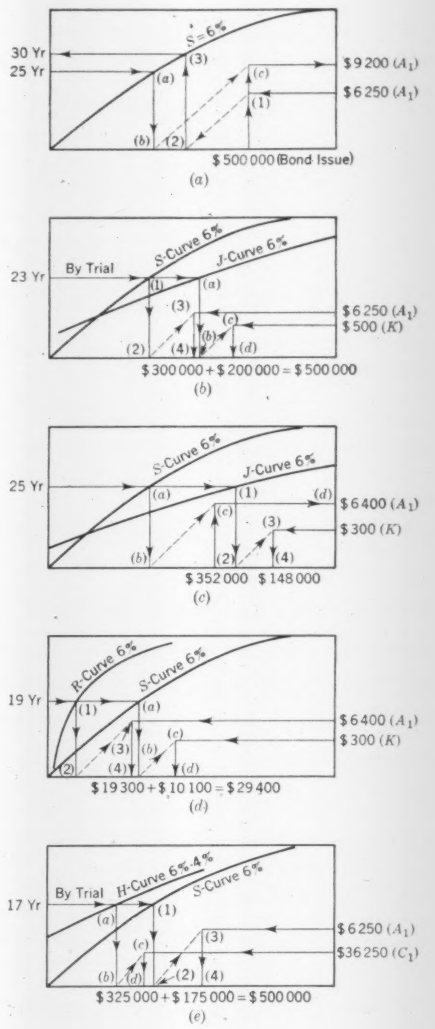

FIG. 2. SKELETON CHARTS, ILLUSTRATING SOLUTION OF TYPICAL PROBLEMS

The period of the loan can be determined by equating Formula 4 to the amount of the bond issue and solving for n. Or the solution may be obtained from Fig. 1, as follows:

First, subtract the interest for the first year ($30,000) from the amount available the first year, C_1 ($36,250) to obtain the amortization for the first year, A_1 ($6,250). Then, as indicated in outline in Fig. 2(*a*), find in Fig. 1 the intersection (1) of the horizontal monetary unit $6,250 ($A_1$, amortization first year) with the vertical monetary unit $500,000 (principal). Then extend diagonally downward to the base line (2), then vertically upward to intersect (3) the 6 per cent (rate of interest) *S*-curve, and find, horizontally on scale at left, 30 years as the period of time necessary to amortize the $500,000 principal.

The total debt service, given by Formula 3, is $nC_1 = 30 \times \$36{,}250 = \$1{,}087{,}500$.

Case I, Problem 2. Given a 6 per cent serial bond issue for $500,000, to be amortized in 25 years. To find the annual uniform debt service.

From the intersection (*a*) of the 25-year line with the 6 per cent *S*-curve [Fig. 2(*a*)], follow vertical lines to base of diagram (*b*), then parallel guide lines upward to the right to intersect (*c*) the vertical monetary unit $500,000, then horizontally to scale at right, and read $9,200, which is the required amortization the first year, A_1. Add to this the interest for the first year ($30,000) and obtain $39,200, the annual uniform debt service to retire $500,000 in 25 years.

Case II, Problem 1. Given a 6 per cent bond issue of $500,000, to be retired by an annual payment which at the end of the first year is $36,250, and which increases annually by the uniform amount of $500. To find the period of the loan.

Find the amount of A_1, as under Case I. Assume the number of years for the period of the loan; then, as indicated in Fig. 2(*b*), enter Fig. 1 on the horizontal line representing the assumed number of years and proceed horizontally to the right to intersect (1) the 6 per cent (rate of interest) *S*-curve; then extend vertically downward to the base line (2); then diagonally upward to the right to intersect (3) the horizontal monetary unit $6,250 ($A_1$, amortization first year). Note the vertical monetary unit on which this intersection falls. (This quantity represents A_1S_r, and equals $300,000 in the final solution of this problem as shown in Fig. 2*b*.) Next proceed, as before, along the line of the assumed period to intersect (*a*) the 6 per cent *J*-curve; then extend vertically downward to the base line (*b*); then diagonally upward to the right to intersect (*c*) the horizontal monetary unit $500 ($K$, uniform amount of increase). Note the vertical monetary unit on which this intersection falls. (This

TABLE I. FORMULAS APPLICABLE TO ANALYSIS OF SERIAL BONDS

FORMULA NO.	QUANTITY		CASE I	CASE II*	CASE III†	
					WHEN $r \neq p$	WHEN $r = p$
1	C_n	=	C_1	$C_1 + (n-1)K$	C_1P^{n-1}	C_1P^{n-1}
2	A_n	=	A_1R^{n-1}	$A_1R^{n-1} + K(R^{n-1} - 1)/r$	$A_1R^{n-1} + C_1p\left(\frac{R^{n-1} - P^{n-1}}{r - p}\right)$	$A_1R^{n-1} + C_1p(n-1)R^{n-2}$
3	$C_1 + C_2 + \ldots + C_n$	=	nC_1	$n\left(C_1 + \frac{n-1}{2}K\right)$	C_1S_p	C_1S_p
4	$A_1 + A_2 + \ldots + A_n$	=	A_1S_r	$A_1S_r + JK$	$A_1S_r + C_1H$	$A_1S_r + C_1H$

* In Formula 4, $J = \frac{S_r - n}{r}$

† In Formula 4, when $r \neq p$, $H = \frac{p}{r-p}(S_r - S_p)$; when $r = p$, $H = (n-1)R^{n-1} - (R^{n-1} - 1)/r$.

quantity represents JK, and equals \$200,000 in the final solution.) If the sum of A_1S_r and JK is equal to the bond issue, the assumed period is correct. If the sum is less, assume a longer period; if more, assume a shorter period. For this problem a period of 23 years satisfies the conditions.

Case II, Problem 2. Given a 6 per cent serial bond issue for \$500,000 to be amortized in 25 years; the amount available for debt service will increase annually by \$300. To find the debt service required in the first year and the amortization in the twentieth year.

As indicated in outline in Fig. 2(*c*), enter Fig. 1 on the horizontal line representing the given number of years and proceed horizontally to the right to intersect (1) the 6 per cent (rate of interest) J-curve; then extend vertically downward to the base line (2); then diagonally upward to the right to intersect (3) the horizontal monetary unit \$300 (K, uniform amount of increase); then extend vertically downward to the scale at the base and read \$148,000. The amount thus determined is that part of the principal retired by the uniform amount of increase, which, taken from the total bond issue of \$500,000, leaves \$352,000 to be retired by the remainder of the amount available beginning with amortization the first year, A_1. Then as again indicated in Fig. 2(*c*), enter Fig. 1 on the 25-year line as before, proceeding horizontally to the right to intersect (*a*) the 6 per cent (rate of interest) S-curve; then extend vertically downward to the base line (*b*); then diagonally upward to the right to intersect (*c*) the vertical monetary unit \$352,000; then horizontally on the scale at the right read \$6,400 (A_1, amortization the first year). The debt service required in the first year will then be \$6,400 plus \$30,000 or \$36,400.

Amortization in the twentieth year is given by Formula 2 of Table I. The solution can be secured mathematically, but an approximate solution can be obtained from Fig. 1. As indicated in outline in Fig. 2(*d*), find the intersection (1) of the horizontal line representing 19 years ($n-1$) with the 6 per cent R-curve; then proceed vertically downward to the base line (2); then diagonally upward to the right to intersect (3) the horizontal monetary unit \$6,400 (A_1, as found in the first part of this problem); then vertically downward and read on the monetary scale at the base \$19,300, the value of A_1R^{n-1}. Then find the intersection (*a*) of the 19-year line with the 6 per cent S-curve; then proceed vertically downward to the base (*b*); then diagonally upward to the right to intersect (*c*) the horizontal monetary unit \$300 (K, uniform amount of increase); then vertically downward and read on the monetary scale at the base \$10,100, the value of $K(R^{n-1} - 1)/r$. The amortization in the twentieth year is $A_1R^{n-1} + K(R^{n-1} - 1)/r$, or \$19,300 + \$10,100.

Case III, Problem 1. Given a 6 per cent bond issue of \$500,000, to be retired by an annual payment which in the first year amounts to \$36,250, and which increases yearly at the rate of 4 per cent (that is, the second year the amount available will be \$36,250 plus 4 per cent of \$36,250, or \$37,700, and so on). To find period of loan.

Find the amount of A_1 as under Case I. Assume the number of years for the period of the loan; then, as indicated in Fig. 2(*e*), enter Fig. 1 on the horizontal line representing the assumed number of years and proceed horizontally to the right to intersect (1) the 6 per cent (rate of interest) S-curve; then extend vertically downward to the base line (2); then diagonally upward to the right to intersect (3) the horizontal monetary unit \$6,250 (A_1, amortization first year). Note the vertical monetary unit on which this intersection falls. (This quantity represents A_1S_r, and equals \$175,000 in the final solution of this problem as shown in Fig. 2 *e*.) Next proceed as before along the line of the assumed number of years to intersect (*a*) the 6%–4% H-curve; then extend vertically downward to the base line (*b*); then diagonally upward to the right to intersect (*c*) the horizontal monetary unit \$36,250 (C_1, amount available first year). Note the vertical monetary unit on which this intersection falls. (This quantity represents C_1H and equals \$325,000 in the final solution.) If, as in Case II, the sum $A_1S_r + C_1H$ is equal to the bond issue, the assumption as to the period of the loan is correct. In this problem a period of 17 years satisfies the conditions.

TABLE II. FORMULAS APPLICABLE TO TERM BONDS

ITEM	CASE A	CASE B	CASE C
Annual payment, *n*th year . .	y	$y + (n - 1)K'$	yP'^{n-1}
Accumulated amount, *n*th year*	yS_r'	$y\,S_r' + \frac{S_r' - n}{r'}K'$	$\begin{cases} y\,\frac{(R'^n - p'^n)}{r' - p'} \\ ynR'^{n-1} \end{cases}$
Summation of annual payments, including *n*th year	ny	$n(y + \frac{n-1}{2}K')$	yS_p'

* In Case C, the first formula applies when $r' \neq p'$; the second formula applies when $r' = p'$.

Case III, Note. If the bond issue and the loan period are given under Case III, and it is desired to determine the debt service required in the first year, the procedure is similar to the method used in Problem 2 under Case II. The H-curve corresponding to the bond interest rate and the uniform percentage of increase is used in place of the J-curve as described under Case II. It is evident that under both Cases II and III either the annual increase in the amount available, or the amount available for the first year, must be assumed if these factors are not known.

FORMULAS FOR TERM BONDS

The different conditions met under the method of financing when term bonds are used may be classified in a manner similar to that used under serial bonds, by grouping them according to the law to which the annual sinking fund payment conforms. The three cases are: (*A*) Annual payment to sinking fund uniform during life of loan; (*B*) increases annually by uniform amount; (*C*) increases annually by a uniform percentage. In all cases, the annual interest payment is uniform throughout the period of the loan. The unknown amounts are the annual payment into the sinking fund to retire principal; the accumulated amount in the sinking fund to retire principal at the termination of any given number of years; and the summation of annual payments to retire principal. The modifications of the formulas shown in Table I for determining the unknown quantities are shown in Table II.

NOMENCLATURE

C_1 = amount available for interest and amortization, first year
C_n = amount available for interest and amortization, *n*th year
r = rate of interest, compounded annually, expressed decimally
K = uniform increase, Case II
p = percentage of increase, Case III, expressed decimally
A_1 = amortization, first year
A_n = amortization, *n*th year
n = number of years (transactions at end of year)
$R = 1 + r$
$P = 1 + p$
$S_r = (R^n - 1)/r$
$S_p = (P^n - 1)/p$
J and H, for definitions see Table I, footnotes.

ADDITIONAL SYMBOLS USED IN TERM-BOND FORMULAS

y = sinking fund payment end of first year
K' = uniform increase in annual payment to retire principal
p' = percentage of increase in annual payment to retire principal
r' = interest rate on sinking fund (not bond interest rate)
R', P', $S_{r'}$, and $S_{p'}$ correspond to R, P, S_r, and S_p, respectively.

The Mortimer E. Cooley Bridge

Graceful Proportions and Pleasing Details Characterize Prize-Winning Steel Structure

By L. W. Millard

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Bridge Engineer, State Highway Department, Lansing, Mich.

Awarded first prize by the American Institute of Steel Construction as the most beautiful bridge of its class built in the United States during 1935, the Mortimer E. Cooley Bridge, named for an Honorary Member of the Society, is well proportioned and pleasing throughout, without superficial ornamentation. Yet it was constructed at no appreciable increase in cost over that of a more standardized design. The bridge's two 125-ft deck-truss steel cantilever arms, supporting a 50-ft suspended section, are balanced by two 125-ft anchor arms tied to concrete abutments. The general proportions were determined by the study of numerous sketches. The appearance of the bridge was enhanced by harmonious proportions and careful attention to details, as explained in the accompanying article on its design and construction, abstracted from Mr. Millard's address delivered on January 8, 1937, before the Detroit Section of the Society.

Located on Michigan State Highway Route M-55, twenty-four miles east of Manistee, the Mortimer E. Cooley Bridge crosses over the south branch of the Manistee River between the Tippy Dam and the Stronach Dam, both owned by the Consumers Power Company. This section is one of the most scenic in Michigan. The site of the bridge is in the center of a horseshoe bend in the tail end of an artificial lake three miles long formed by the Tippy Dam. The ground is practically flat for a distance of 400 ft from the river bank on the east side and 600 ft on the west side. It then rises sharply to form high bluffs approximately 100 ft above the water.

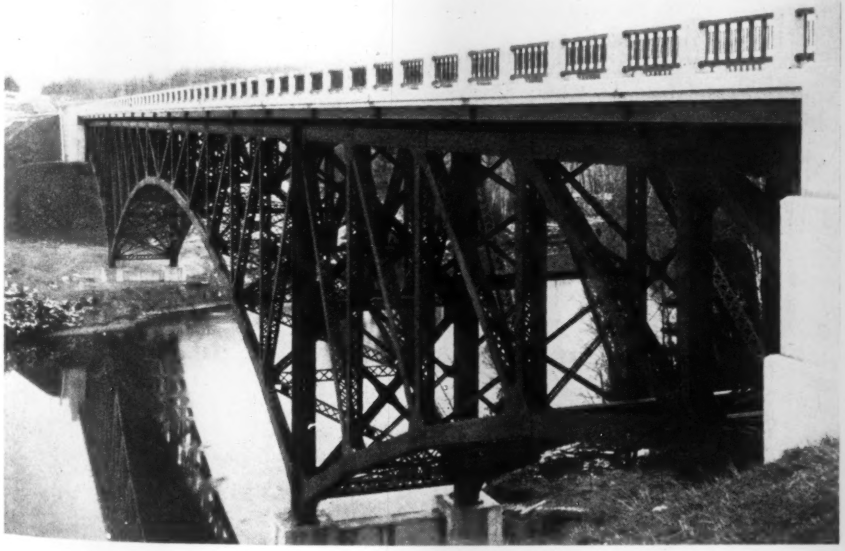
It soon became apparent that a high-level bridge was preferable to a low-level structure, since the cost of satisfactory approach cuts would be prohibitive. The natural beauty of the setting called for a type of construction that would harmonize with it, and two general features of the bridge were thus determined. We next considered whether the structure should be a trestle, arch, truss, or (even) a self-anchored suspension span. A cantilever deck truss was eventually selected as the best type, and detailed preliminary designs were begun. One of our objectives was to carry practically all the load on the piers, which were to be founded in hard clay, permitting the abutments to be set well back in the approach fills.

Among the arrangements considered was one for a simple main span with the cantilever arms ending in short I-beam gang-plank spans to allow for the live-load deflections at the ends of the cantilevers. This truss required a greater depth at the center of the main span than was desirable from the standpoint of appearance, and gave rise to difficult expansion problems at the pier bearings, and even more difficult approach-ramp details. Finally it was found from deflection studies that the ends of the cantilevers might move several inches vertically with the passage of loads. This condition, which would have necessitated varying grades for the approach ramps, was ultimately responsible for our discarding the plan.

Later we decided to tie down the abutment ends of the bridge to eliminate practically all the vertical movement at those points. Such a vertical tie would require an anchorage, and this could be provided in the abutments. With the ends of the bridge tied down, it would be possible to cut the main span and support a short suspended span on the two cantilever arms. In this way the depth of the truss at the center of the main span would depend only upon the requirements of good proportions and appearance. The ties to the abutments were designed as tye-bar links, and sliding bearings were provided for the suspended span, all to permit horizontal movement due to temperature and stress deformation. These details obviated the necessity for expansion bearings on either pier.

The preliminary plan decided upon thus resolved itself into a 300-ft main span consisting of 125-ft cantilever arms resting on concrete piers and supporting a 50-ft suspended section, flanked by two 125-ft anchor arms which are tied to concrete abutments (Fig. 1). The design was made in accordance with the H-15 live-loading specifications of the Michigan State Highway Department then in force, which set the basic allowable unit stresses at 16,000 lb per sq in. for steel and 950 lb per sq in. for concrete.

The piers, which are almost completely buried, are simple pedestals of concete transmitting a direct pres-



General View of Cooley Bridge Over the Manistee River, Michigan sure, under full vertical load, of 2 tons per sq ft, approximately. The extreme toe pressure due to a combination of all vertical and horizontal loads is about 3 tons per sq ft. (The safe bearing power of the hard clay under the piers was considered to be between 3 and 4 tons per sq ft.)

ABUTMENTS DESIGNED LIKE BUILDING FRAMES

The abutments are of an unusual type and their design presented a difficult problem. As constructed, these units resemble concrete building frames, and in fact they were similarly designed except that an active earth pressure was used in place of a wind load. The method generally used for computing lateral earth pressures on walls and abutments was somewhat modified, as it was assumed that the fills would be placed and compacted in thin horizontal layers to the finished slope lines all around the abutments.

In both abutments, the columns are tied together with two sets of reinforced-concrete struts, forming a frame almost identical with the frame of a reinforced-concrete building. This arrangement allowed the dirt to spill through, thus relieving the earth pressure. On top of this frame were placed several lifts of heavily reinforced concrete walls, forming the wing walls of the abutment. These are also tied together with struts, and each lift is set back from the one below. The west abutment has three lifts and the east abutment four.

One of the unusual features of the bridge is a reinforced-concrete stairway 4 ft wide at each right-hand approach. Each stair is carried down the side of the abutment on reinforced-concrete brackets to a point where the bottom chord of the anchor-arm arches into the abutment. From this point a winding path leads down the side slopes, giving access to views of the river and of the cantilever arch. In this way access is also provided to a roadside park on the west river bank, which is a very popular spot for picnickers and sightseers.

The trusses were designed by a cut-and-try process. Dead loads were first assumed. Then stress diagrams based on those assumptions were drawn, the required sections computed, and dead loads adjusted accordingly. Graphics were used almost entirely in determining stresses, but the final stress diagram was checked analytically. The distribution of truck loads over the structure for maximum and minimum stresses was thoroughly studied, special attention being given to the effect on the anchor links of various arrangements of the live loads. These links were designed for tension only, as the work and wear on the pins that would be occasioned by reversals of stress was not considered desirable. It was therefore necessary to so proportion the spans and distribute the dead load that the most unfavorable condition of live loading would not completely equalize the tension in the links produced by dead load. To insure this tension without making extensive changes in the structure itself, the thickness of the concrete deck on the suspended span was increased 3 in. over the thickness usually required.

Deformations due to dead-load stresses were very thoroughly studied by means of Williot diagrams, and the increase or decrease in the theoretical length of each member of the trusses to compensate for these deforma-

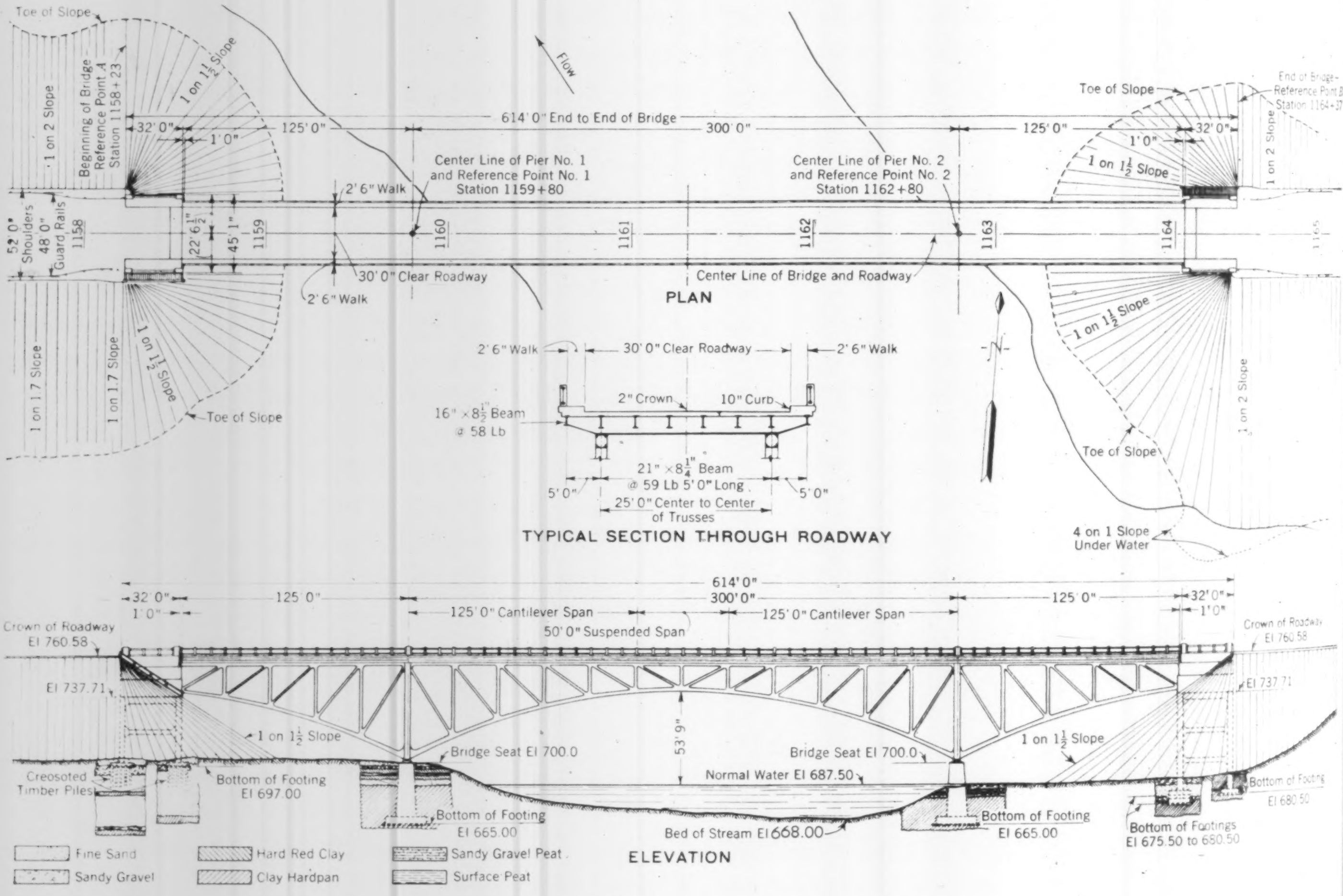

Toe of Slope
1 on 2 Slope
Beginning of Bridge Reference Point A Station 1158+23
1 on 1½ Slope
Flow
614' 0" End to End of Bridge
32' 0"
1' 0"
125' 0"
300' 0"
125' 0"
Center Line of Pier No. 1 and Reference Point No. 1 Station 1159+80
Center Line of Pier No. 2 and Reference Point No. 2 Station 1162+80
End of Bridge Reference Point B Station 1164+37
2' 6" Walk
52' 0" Shoulders
48' 0" Guard Rails
22' 6½"
45' 1"
1158
1159
1160
1161
1162
1163
1164
30' 0" Clear Roadway
Center Line of Bridge and Roadway
PLAN
1 on 1.7 Slope
N
2" Crown
10" Curb
16" × 8½" Beam @ 58 Lb
21" × 8¼" Beam @ 59 Lb 5' 0" Long
5' 0"
25' 0" Center to Center of Trusses
TYPICAL SECTION THROUGH ROADWAY
4 on 1 Slope Under Water
614' 0"
125' 0" Cantilever Span
50' 0" Suspended Span
Crown of Roadway El 760.58
El 737.71
Bridge Seat El 700.0
53' 9"
Normal Water El 687.50
Creosoted Timber Piles
Bottom of Footing El 697.00
Bottom of Footing El 665.00
Bed of Stream El 668.00
Bottom of Footings El 675.50 to 680.50
Bottom of Footing El 680.50
ELEVATION
Fine Sand
Sandy Gravel
Hard Red Clay
Clay Hardpan
Sandy Gravel Peat
Surface Peat

FIG. 1. ELEVATION OF MORTIMER E. COOLEY BRIDGE, LOOKING NORTH

tions was indicated on the plans. A permanent parabolic camber with a 12-in. maximum ordinate was provided as an allowance for the effects of live loads, temperature changes, and optical illusion. The dead-load deflections of the trusses were of such magnitude that it seemed advisable to employ an unusual method for connecting stringers to floorbeams, so as to prevent the stringers from being forced to carry upper-chord stresses. All stringers (except those for the suspended span) were shipped with the connection angles on one end loose, and the holes subpunched only. When the stringers were erected, the free angles were riveted to the floor beams and bolted to the stringers, but the bolts were not drawn up tight. As a result, when the concrete deck was poured, and the trusses deformed under its weight, there was a little play at each of these connections. The floor of the suspended span was poured first, and the pouring progressed thence towards the abutments. After the entire deck was in place, the bolted stringer-connections were field-reamed and riveted.

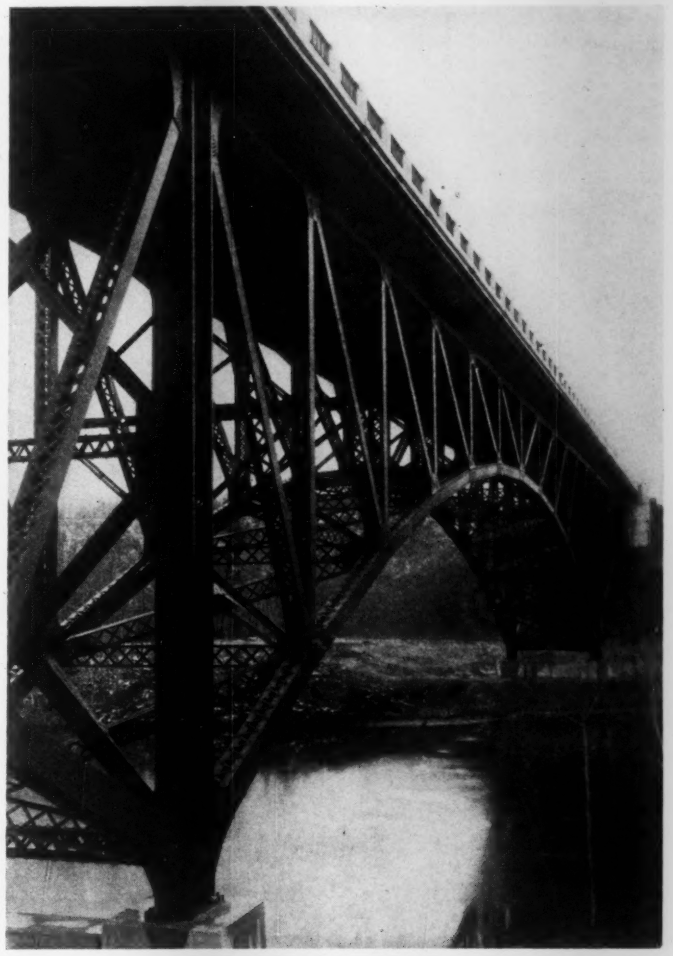
Throughout the entire design of this bridge, an effort was made to have it pleasing in appearance without the use of superficial ornamentation and without increasing its cost appreciably. To this end, the general proportions were studied by means of a considerable number of sketches and preliminary drawings; the chord sections were detailed with the webs out; the main gusset plates were cut on curves; the pier shoes were hidden in the ends of the main verticals; the lower-chord members connected to the main vertical were tapered slightly; at each end of the floorbeams a triangular section was burned off the web just above the lower flange and the flange welded back to the web to form a cantilever bracket; and the substructure units were planned as harmonious masses of concrete.

ATTENTION TO ESTHETICS FAILS TO RAISE COST

The construction work was carried out under three contracts—one for the substructure, another for the superstructure, and a third for the approach grading and road-surfacing work. The latter contract covered sufficient road work at each end of the structure to connect the bridge with the existing road at each end—a total distance of 4,100 ft, including the bridge. The superstructure contract required the fabricator of the steel to do the erecting also. The total structure cost under the first two contracts was $179,683.88 (making a structure cost just slightly over $8 per sq ft of roadway and sidewalk), which was $15,906.10 above the original bid. This increase was almost entirely due to the fact that the steel weights had been underestimated originally.

Some phases of the construction work are of interest. From the standpoint of moving heavy equipment and locating a concreting plant, the bridge site appeared almost inaccessible before the work was started. On the west bank, the substructure contractor solved this problem by constructing a timber trestle from Loomis Landing, which was accessible from the old low-level road, across the river to the site of the work. This timber trestle was 280 ft long, with piles driven in 18 ft of water. All material and equipment used on the east bank were brought in from the old road through a short section of woods road. By the time structural steel was needed, a large part of the road approach fills were completed and steel for the east side came in over the new fill.

Construction of the west pier and abutment was started first. The footings are founded in clay hardpan 4 ft below the bed of the stream and 23 ft below normal water elevation. Cofferdams consisting of interlocking steel sheet-piling 35 ft long, with three sets of heavy timber walers for bracing, were constructed around the piers. Each line of walers was located one foot above the horizontal construction joints in the piers. After each lift had been poured and the concrete hardened, the cofferdam was braced to the completed section and the next lift of bracing removed to facilitate construction of the forms. Considerable difficulty was encountered in driving the sheet-piling on account of the hardness of the clay, and it finally proved necessary to dig out from under the tips with air spades for every 3 or 4 ft before driving the sections down. Practically all the excavation in both piers had to be dug loose with air spades, loaded into steel buckets, and hoisted out by crane.

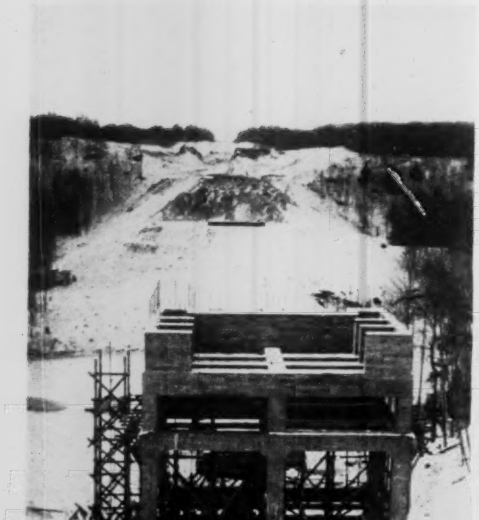


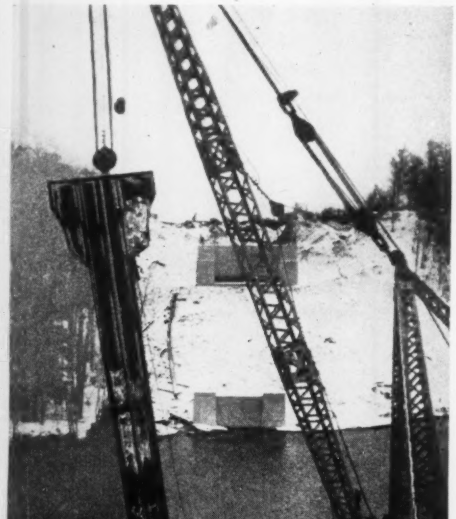
A Pleasing Appearance Without Superficial Ornamentation

Note the Chord Sections with Webs Out, Curved Main Gusset Plates, Pier Shoe Hidden by Main Vertical, and Triangular Shape of Cantilevered Floor Beams

The abutments are each constructed with six reinforced columns. The west abutment, having a height of 64 ft $3^1/_2$ in., is carried on spread footings, each supported on 25 treated timber piles jetted down through the sand to hardpan and then driven to bearing. The east abutment is founded on lower ground than the west one, and piles were not required, as the footings could be placed upon clay hardpan. The east abutment rises 80 ft $9^1/_2$ in. from the bottom of the footings, and caused much concern at one time, as will be explained hereinafter.

Approximately 300,000 cu yd of fill were used in the approaches. The material being practically all sand, it was placed by means of hydraulic sluicing. A large hopper was constructed, with metal-lined flumes leading from it down to the cut. Large centrifugal pumps located on the river bank supplied the hopper with high-pressure streams of water through fire hose, and steam shovels loaded it with sand. Dikes were constructed at the lower end of the filling operations by use of a bulldozer, but most of the water soaked away before it reached them.


East Abutment of the Bridge, Showing Its Resemblance to a Reinforced-Concrete Building Frame


Main Posts Are 57 Ft 6 In. Long and Weigh 20 Tons. A 35-Ton Derrick with 85-Ft Boom Was Used in Erection

From the footings of the east abutment to the river channel the clay was found to be overlain with from 2 to 10 ft of muck. This entire area was to be covered with fresh fill, so that the muck had to be removed. As the area was practically inaccessible at the beginning of the work, considerable difficulty was encountered in the work of removal. The muck was nevertheless removed to an extent such that it was believed no trouble would be experienced from settlement or displacement of fill. Later events made us doubt, however, whether all of it was actually excavated.

The road fill was placed around the abutments by sluicing, as mentioned before. In the case of the east abutment, the fill was carried up to a point approximately 15 ft below final grade in the late fall. It is probable that some water was frozen in the earth, and that the resulting fill was therefore none too stable. The following spring, after all concrete in the abutment had been poured except the last lift, and while the anchor-arm steel was being erected on falsework supported by the fill in front of the abutment, the road contractor began the final filling.

On April 10, 1935, it was discovered that this abutment was moving toward the river. Orders were immediately issued to remove all road fill in the abutment area above the bridge-seat elevation. The forward movement stopped while this was being done, the face of the abutment having moved forward approximately 5 in. As soon as the earth removal had been completed, the abutment came back $1\frac{1}{2}$ in. The design of the top of the abutments was immediately changed by eliminating all earth fill in their upper portions, flooring them over with a concrete deck, and placing a retaining-wall section from wing to wing. This of course threw the earth pressure against the rear wall instead of the forward wall and materially reduced the toe pressure.

The anchor beam on the abutment was moved back 12 in. and the concrete on the face of the center vertical strut was trimmed off 12 in. This provides ample clearance between the anchor-arm steel and the abutment, and allows for a reasonable future movement, if such should occur. Check readings for several months after the abutment was constructed showed no movement, nor are there any indications to date of any further movement.

A 35-ton A-frame derrick, with an 85-ft boom, was used to erect the main posts and anchor arms. After the anchor arms were erected, a 5-ton derrick was placed on top to erect the cantilever arms and suspended spans. Before starting erection of the cantilever steel, the eye-bars connecting the ends of the anchor arms to the anchor beams had to be placed, and all chord splices in tension members riveted. Over 20,000 field rivets were driven during structural-steel erection. The concrete slabs on the structural steel were poured in such a manner as to keep a uniform loading on the bridge.

The total length of the structure is 614 ft along the center line of the roadway. Two walks 2 ft 6 in. wide are provided on each side of the 30-ft roadway. The distance from the crown of the roadway to the normal water surface is approximately 75 ft.

This bridge was dedicated on September 13, 1935, by State Highway Commissioner Murray D. Van Wagoner, under whose administration the structure was designed and built, and was named the Mortimer E. Cooley Bridge in honor of Dean Cooley, Hon. M. Am. Soc. C.E., dean emeritus of the Colleges of Engineering and Architecture, University of Michigan. The Mortimer E. Cooley Bridge was awarded first prize by the American Institute of Steel Construction as the most beautiful bridge in its class built in the United States during 1935.

The three men directly responsible for the design and construction of this bridge are J. H. Cissel, M. Am. Soc. C.E., engineer of bridge design (now professor of structural engineering, University of Michigan); J. H. Flynn, engineer of bridge construction (now assistant bridge engineer); and the author, bridge engineer.

Water Purification and Public Health

A Review of Twentieth-Century Advances in Purifying Public Water Supplies

By the late John H. Gregory

Member American Society of Civil Engineers
Professor of Civil and Sanitary Engineering, The Johns Hopkins University, Baltimore, Md.

Marked developments have taken place in the art of water purification in this country since the beginning of the century. The use of chemicals to remove turbidity, color, and objectionable tastes and odors is one illustration. Another is new processes for removing iron, manganese, carbon dioxide, and for softening water. But most important of all are the improvements along the line of more effective filtration and disinfection. The close connection between these bacteriological advances and the reductions experienced since 1900 in the typhoid-fever death rates of three representative American cities having surface-water supplies is brought out very clearly in the accompanying tables. The article itself is abstracted from a paper prepared by the late Professor Gregory shortly before his death and read by Sheppard T. Powell, chemical engineer, of Baltimore, Md., at the twenty-fifth anniversary celebration of the Johns Hopkins University school of engineering, held at Baltimore in February 1937. Acknowledgment is made of the assistance of Mr. Powell in preparing the abstract for publication.

Of the several branches of sanitary engineering, those of greatest importance are water supply and sewage disposal. Of these, water supply ranks first, for the reason that if the water is unsafe to drink, higher death rates result, especially from certain water-borne diseases, notably typhoid fever. It is here intended to review very briefly some of the broader aspects of what has been accomplished in water purification, primarily in this country, since the beginning of the twentieth century. Prior to 1900 the art of water purification was but little practiced, and it has been subsequent to that date that the great advances in the art have been made.

That a better understanding may be had of what has been accomplished, it may be well to state, in simple terms, the principal requirements for a satisfactory public water supply. Assuming that it is sufficient in quantity and delivered at an adequate pressure, a satisfactory water supply may be roughly defined as one in which the water is clear and colorless, free from objectionable tastes and odors, of satisfactory chemical content, soft rather than hard, and of the highest hygienic quality so as to be safe to drink. Many public water supplies do not meet all these requirements because some communities are not sufficiently well educated as to what can be accomplished by water purification, and others are not yet willing to pay the cost.

Water supplies, in general, may be classed as surface supplies and ground-water supplies; waters derived from these two sources are generally quite different in character. Given a certain source of water supply, however, it is the problem of the sanitary engineer to so correct the water that, after purification or treatment, it will be satisfactory from physical, chemical, and bacteriological standpoints. Correction from the physical standpoint will be considered first, then from the chemical, and finally from the bacteriological.

PHYSICAL CORRECTION OF WATER

Surface waters almost always have a certain amount of turbidity, produced by dirt in suspension (either mineral or organic, generally both), coming from surface washings. Turbidity may be reduced in amount by the storage of water in large reservoirs, by its passage through so-called sedimentation basins or settling reservoirs either with or without chemical treatment, by filtration, or by some combination of these methods.

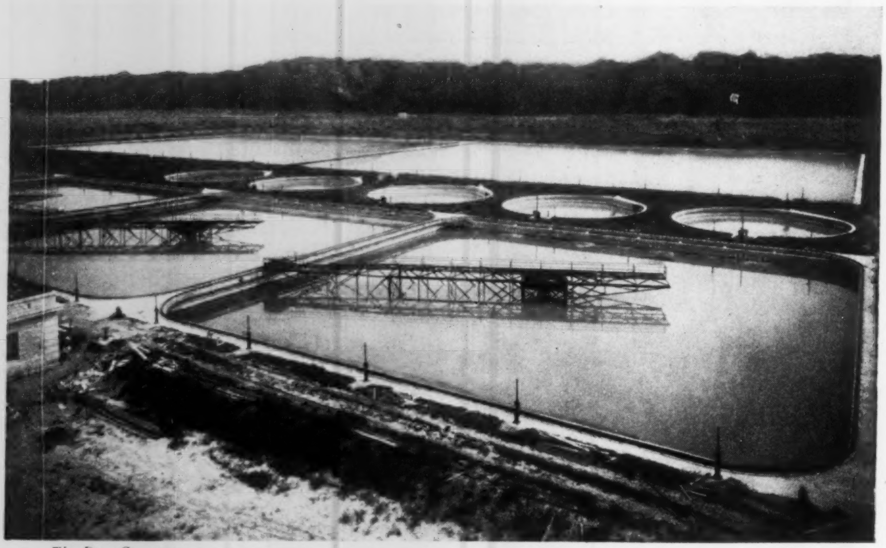
Removal of turbidity simply by storage and sedimentation is seldom sufficient, and resort must then be had to chemical treatment, usually with sulfate of alumina, or lime and ferrous sulfate. The resulting floc settles out in the sedimentation basins and carries down with it most of the turbidity, and the remaining floc and turbidity are removed by filtration. As an illustration, as much as 200 tons of mud per day are at times removed from the raw water at Columbus, Ohio, a city of some 300,000 population.

In general it may be said that, barring those sections of the country where the turbidity is caused by relatively coarse matter, filtration preceded by chemical treatment will be required for its removal. The turbidity may not be reduced absolutely to zero, but should

Baltimore Bureau of Water Supply

General View of the Montebello Filtration Plant, Baltimore, Md.

be so reduced as not to be noticeable by the consumer in a glass of water or in a white bathtub. This can be accomplished, and is being accomplished, by practically every well-operated water-purification plant.



The Dorr Company

SETTLING BASINS WITH MECHANICAL SLUDGE-REMOVAL EQUIPMENT
The Howard Bend Plant at St. Louis, Mo.

Color in a natural water is due to organic matter in solution. Swamp water, for example, has a brown or yellowish brown color due to its lying in a more or less stagnant state in contact with vegetation, either dead or alive, taking tannic or other organic acids into solution. A water may also become colored from contact with certain kinds of vegetation in rivers, streams, ponds, lakes, and storage reservoirs.

Color can be reduced by the bleaching action of the sun, and this can be brought about by storing the water in large reservoirs over long periods of time. In fact, some reservoirs have been built larger than necessary merely to lengthen the time required for the water to pass through and to facilitate the bleaching action. This was the practice in the northeastern part of the country prior to, and at the beginning of the present century. But even with prolonged storage the color may not be reduced sufficiently.

When water began to be treated with sulfate of alumina for the removal of turbidity, it was found that the color was also removed by the adsorptive power of aluminum hydroxide, the precipitate formed when sulfate of alumina is added to water. This was the greatest single advance in the removal of color from water.

Tastes and odors, other than those coming from industrial wastes, are mainly caused by the decomposition of organic matter and by living or dead organisms. Some tastes and odors can be removed, or reduced to such a degree as not to be noticeable, by aeration, but aeration may not be a sufficient corrective.

In the last few years more and more reliance has been placed on treatment of the water with chemicals other than those used for the removal of turbidity and color. The most important of these treatments are the application of chlorine gas and the addition of activated carbon at some stage of purification prior to filtration. Chlorine gas burns up organic taste-producing substances, and activated carbon removes tastes and odors by its adsorptive action. With certain kinds of tastes and odors, both methods of treatment have given very satisfactory results, especially that with activated carbon. Mention should also be made of the ammonia-chlorine treatment, which is effective in preventing the intensification of tastes and odors often brought about by the application of chlorine gas alone.

Some tastes and odors do not fully respond to either the chlorine gas or the activated-carbon treatment, although they may be greatly reduced. It would appear, however, that these cases are relatively few when compared with the many where these treatments have been effective. Treatment with activated carbon has been perhaps the greatest advance in the removal of tastes and odors in the last few years.

ADVANCES IN CHEMICAL CORRECTION

Waters containing free carbon dioxide are corrosive in a degree dependent upon the amount of carbon dioxide present, either naturally or through treatment of the water with sulfate of alumina. Whatever the source, if carbon dioxide is present in sufficient quantity, the water may react with iron and steel pipes or other surfaces, resulting in a reddishness sometimes called red-water plague. The correction lies in decreasing the amount of free carbon dioxide before delivering the water to the distribution system. This may be brought about by aeration, by chemical treatment with lime, or by a combination of the two. Soda ash may also be used. Aeration allows much of the free carbon dioxide to escape to the atmosphere, but in lime treatment the free carbon dioxide combines with the lime to produce either calcium carbonate or calcium bicarbonate, neither of which is corrosive. The water, however, is slightly hardened.

Hardness is generally due to the presence of bicarbonates or sulfates of calcium and magnesium in solution, making the water unsatisfactory for both household and industrial use. The type of treatment depends on the character and degree of the hardness. When bicarbonates are present it may be sufficient to treat the water with lime, breaking up the bicarbonates and precipitating them as calcium carbonate, and as magnesium hydroxide if magnesium also is present. But when sulfate as well as bicarbonates are present, the water is ordinarily treated with lime and soda ash, the reactions here resulting in the precipitation of calcium carbonate and magnesium hydroxide.

The zeolite process of water softening, although known for many years, is now coming more and more to the front, sometimes in combination with the lime and soda-ash treatment. In this process, which requires freedom from turbidity, the water is brought into contact with a natural or artificial zeolite. The zeolite gives up its sodium in exchange for the calcium and magnesium, thus softening the water, and filtration through the zeolite bed is continued until the sodium is exhausted. The bed is then drained and the zeolite regenerated by flooding it with a strong solution of common salt. Base exchange again takes place, the sodium in the salt solution now replacing the calcium and magnesium taken up by the zeolite, and in this manner the zeolite is brought back to its original condition. The bed is again drained and is then washed thoroughly with clean water to remove all traces of the regenerating salt solution.

after which it is once more ready for service. With the lime and soda-ash process there is a limit to the amount of hardness which can be removed, whereas with the zeolite process it is possible to reduce the hardness to practically zero, although I do not know of any public water supply where this is actually being done.

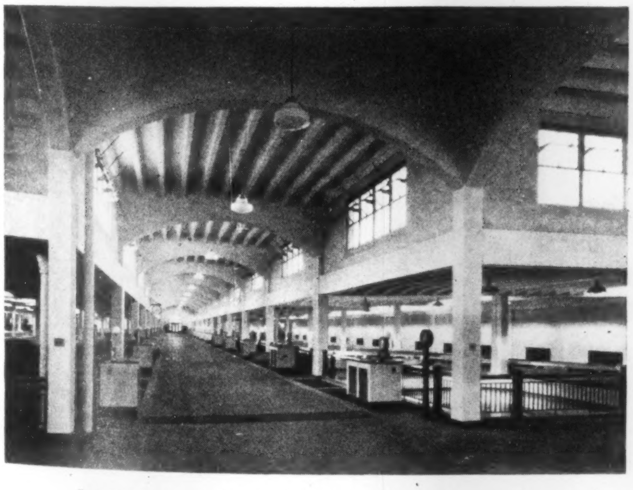
Recent experimental research in England has indicated another possible method of water softening (on a small scale) by the use of synthetic resins. Such resins, when prepared from certain phenols and tannins, are capable of removing calcium and magnesium from hard water, by base exchange, in the same manner as is done by zeolites. The procedure in softening a hard water with these resins is the same as in the zeolite process. The resins are regenerated by treatment with acid solutions, such as hydrochloric acid, or by certain salt solutions. Further research is necessary before it will be possible to say whether or not this process will produce a satisfactory drinking water when applied on a large scale.

Iron in solution in a water may be objectionable if present in excess of a certain percentage. This is often the case with ground waters, the iron being oxidized when the water comes in contact with air, and resulting in a reddish precipitate. Such waters are unsatisfactory for most purposes, as they stain white plumbing fixtures and have an unpleasant taste. Correction lies in reducing the amount of iron by aeration, generally followed by filtration. In some cases the water may also be treated with lime prior to filtration.

When manganese is present in solution, similar difficulties occur, except that the precipitate is blackish, rather than reddish, in appearance. Treatment to remove manganese is similar to that used to remove iron, but it may be necessary to employ the so-called lime and iron process, that is, lime and ferrous sulfate, as used in water filtration, either with or without the addition of sulfate of alumina, prior to filtration.

METHODS OF BACTERIOLOGICAL CORRECTION

Correction of a water from the bacteriological standpoint is, of course, of the greatest importance. Pathogenic bacteria must be removed to the greatest degree possible, so as to prevent the transmission by water of such diseases as typhoid fever. The removal of bacteria from water may be brought about by storage, by disinfection, by filtration, or by a combination of these methods. When water is stored over long periods of time, pathogenic bacteria settle out or die from a changed environment. In this country reliance was at one time placed on storage for such disinfection, but storage alone should not be relied upon today.



Interior of a Modern Filtration Building

Two types of filters are in general use today, the so-called slow sand filter, in which the water passes through the filter at a rate of about 3,000,000 gal per acre per day, and the rapid sand filter, in which the rate may be as high as 125,000,000 gal per acre per day or higher. Which type of filter to use depends largely on the character of the water to be treated and the results to be accomplished in addition to the effective removal of bacteria, as where the turbidity is caused by very finely divided material, for example.

New Filters at the Montebello Plant

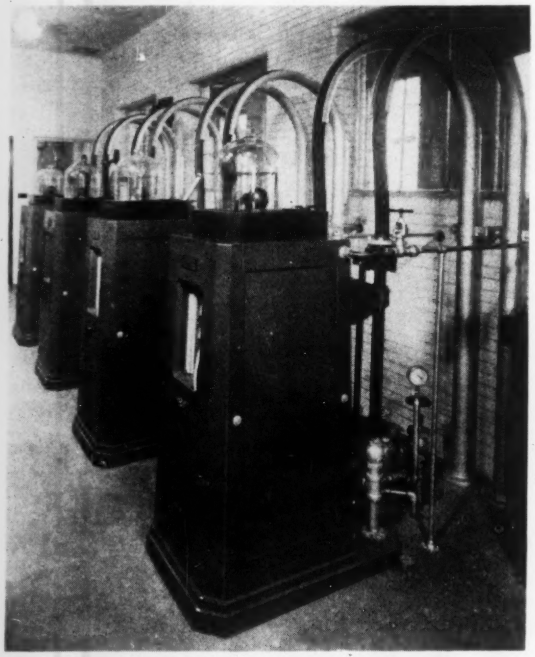
In the early days of filtration no chemicals were used with slow sand filters, but in more recent years it has been increasingly the practice to use chemicals prior to filtration. When chemical treatment precedes slow sand filtration, sulfate of alumina is ordinarily used.

With rapid sand filters, chemicals must be used prior to filtration. Most water purification plants use sulfate of alumina but there are quite a number where lime and ferrous sulfate are employed. With rapid sand filters it may be expected not only that a high bacterial removal will be secured, but also that the filtered water will appear clear, bright, and sparkling.

Disinfection, or killing of bacteria by means of a chemical, may be used solely, or as a further safeguard when water is filtered. Disinfection costs so little that sanitary engineers in general are of the opinion that it should be employed even if apparently not necessary, simply as insurance against unsafe water. When disinfection was first used it was the practice to treat the water with hypochlorite of lime (bleaching powder), but today chlorine gas is almost universally used.

WATER PURIFICATION LOWERS TYPHOID-FEVER DEATH RATES

And now, from the public health standpoint, what has been accomplished by water purification? This may best be judged by the great reductions in typhoid-fever death rates which have taken place in cities in this country since 1900, following the introduction of purified water supplies. While these great reductions are not due solely to water purification, by and large water purification has been the greatest factor. Typhoid-fever death rates will be cited for three cities—Chicago, Philadelphia, and Pittsburgh. Chicago employs chlorination alone; Philadelphia, filtration and chlorination; and Pittsburgh, filtration alone.



Wallace and Tiernan

CHLORINATORS FOR STERILIZING WATER AT CERMAK STATION, CHICAGO

Chicago gets its water supply from Lake Michigan, the intakes being offshore along the waterfront. In early years the sewage of the city was discharged direct into the lake, but with the opening of the Chicago Drainage Canal in January 1900, sewage was diverted. Subsequently, intercepting sewers and the Calumet-Sag Channel, another drainage canal, have been completed; water-works intakes have been extended further offshore; and new intakes have been built. In January 1910, pasteurization of the milk was instituted, and in January 1912, twenty-five years ago, chlorination of the water supply was started. Complete chlorination of the water was not secured until December 1916. The great reductions in the typhoid-fever death rates in Chicago are of especial interest because, following complete chlorination, that city has had one of the lowest typhoid-fever death rates of any of the large cities in the world. In Table I a record of the variation of these rates from 1891 to 1935 is given, with explanations of the critical points.

TABLE I. TYPHOID-FEVER DEATH RATES IN CHICAGO

YEAR	DEATH RATE PER 100,000 POPULATION	REMARKS
1891	174	All time typhoid-fever death-rate peak
1892	124	....
1893	54	....
1898	40	....
1900	20	Drainage Canal opened
1902	45	....
1903	32	....
1909	13	....
1910	14	Pasteurization of milk (January)
1912	11	Chlorination of water (January)
1916	5	Complete chlorination of water (December)
1916–1920	2.4*	....
1921–1925	1.4*	....
1926–1930	0.6*	....
1933	0.3*	....
1934	0.6*	....
1935	0.4*	....

* Records taken from *Journal of American Water Works Association* for July 1925, June 1927, August 1933, and August 1936.

Philadelphia obtains its water supply from the Delaware and the Schuylkill rivers, all the water from both sources now being filtered and chlorinated. Filtration began in 1902. By 1910, 86 per cent of the water supply was being filtered, and since 1913 all the water has been filtered and chlorinated. The corresponding reductions in the death rates are shown in Table II.

TABLE II. TYPHOID-FEVER DEATH RATES IN PHILADELPHIA*

YEAR	DEATH RATE PER 100,000 POPULATION	YEAR	DEATH RATE PER 100,000 POPULATION
1888	78.2	1921	2.3
1888–1897	Steady reduction	1922	2.7
1897	33.0	1923	1.7
1899	74.0	1924	2.2
1901	33.7	1925	2.3
1903	70.1	1926	1.9
1905	48.3	1930	0.9
1910	17.4	1931	0.9
1913	15.7	1932	1.3
1914	7.5	1933	0.6
1915	6.5	1934	0.9
1918	4.8	1935	0.9
1920	3.4		

* Records taken from *Journal of American Water Works Association* for May 1923, July 1925, June 1927, and August 1936.

The Allegheny River is the source of water supply for the city of Pittsburgh. Prior to filtration the typhoid-fever death rates were high. The all-time typhoid-fever death-rate peak was in 1882, when it reached 158 per 100,000 population. This is double the all-time peak in Philadelphia of 78.2, but less than the all-time peak in Chicago of 174 per 100,000. Significant changes in the death rate are given in Table III. It will be noted that, prior to filtration, the average typhoid-fever death rate for 28 years was 107 per 100,000, whereas in 1933 it was only 0.1 per 100,000.

It may also be of interest to compare the death rates per 100,000 in Pittsburgh from typhoid fever with those from lobar pneumonia, bronchopneumonia, and tuberculosis, for 1907, the year the first filter was started, and for 1935. Lobar pneumonia dropped from a rate of 117 to 101 per 100,000, bronchopneumonia from 131 to 40.4, tuberculosis from 129 to 47.4, and typhoid fever from 107 to 0.44. In the accompanying Table IV, figures are also given for the intermediate year 1922.

TABLE III. TYPHOID-FEVER DEATH RATES IN PITTSBURGH

YEAR	DEATH RATE PER 100,000 POPULATION	REMARKS
1882	158	All-time typhoid-fever death-rate peak
1880–1907	107	Average for 28 years
1907	125.2	First filter started
1908	48.7	All water filtered by end of year
1909–1918	16.7	Average for 10 years
1919–1928	3.9	Average for 10 years
1929	2.3	....
1929–1935	1.2	Average for 7 years
1933	0.1	All-time low

Thus it is seen that in addition to the striking reduction in typhoid fever, there has also been a substantial reduction in other diseases, which can be traced to the treatment of public water supplies. The total amount of improvement in public health can scarcely be measured, but it has certainly been very great. Sanitary engineers may well be proud of the part they have played in the spectacular drop in the death rate which has occurred in recent years.

TABLE IV. DEATH RATES FROM LOBAR PNEUMONIA, BRONCHOPNEUMONIA, TUBERCULOSIS, AND TYPHOID FEVER IN PITTSBURGH IN 1907, 1922, AND 1935

(Non-Inhabitants in Institutions Not Included)

CAUSE OF DEATH	DEATH RATE PER 100,000 POPULATION		
	1907	1922	1935
Lobar pneumonia	117	154	101
Broncopneumonia	131	106	40.4
Tubêrculosis	129	80.6	47.4
Typhoid fever	107	3.3	0.44

City Management an Engineer's Profession

Some Pertinent Facts About an Occupation for Which Engineers Are Well Qualified

By Evelyn E. Brackett
Oakland, Me.

Regarded by many as the most promising form of American municipal government today, the city-management system has had a rapid growth. Occasionally expectations, sometimes unreasonable, have not been fulfilled, but the increase in the number of municipalities having this form of government from one in 1908 to 466 in 1936 is incontrovertible evidence of the system's success. Of special interest to engineers, however, is a recent occupational classification which shows that 398 out of 863 city and county managers, or 46 per cent, are engineers. The next largest occupational class from which managers are drawn is the business or executive group, providing only about 12 per cent. The duties of the average city manager, as described by Mrs. Brackett in the accompanying article, include many which the engineer is by training and experience well fitted to perform.

THE rise of the profession of city management is the expression of an attitude on the part of the people—a growing realization of the importance of what is known as "the technique of municipal administration." This expression of popular opinion has taken the form of votes cast in cities and towns large and small for the council-manager type of municipal government. It has unobtrusively been taking root during the last quarter of a century, and is now growing in the very close vicinity of the age-old tree of engineering.

For a definition of the term "city manager," we have the following: "A professional man, preferably a civil engineer, who furnishes the method and facilities for planning and carrying out the best in municipal government and city growth."

In the city of Staunton, Va., it happened that a leaking dam gave way one spring, and the local contractors would bid no lower than $4,000 for making the necessary repairs. Charles E. Ashburner, then maintenance engineer for the Chesapeake and Ohio Railroad, was asked by a friend in the city council if he would estimate what such repairs should cost. He said that the work could be done for $737 if his recommendations were followed. The council took his advice and completed the job for $736! Within a short time, two of Staunton's leading business men, H. C. Braxton, then city councilor, and Stephen Timberlake, an attorney, proposed that a "general manager" be chosen to assume full control of the city's business. For this office Mr. Ashburner was unanimously selected by the council, at a salary of $2,500. He remained in Staunton for three years. Later he became manager of Springfield, Ohio, at a salary of $6,000; then of Norfolk, Va., at a salary of $9,000, which was raised to $16,000 in 1923. In that year, however, he was chosen manager of Stockton, Calif., at a salary of $20,000.

This same story, modified a little here and there, may be told today of cities and towns all over the country. The value of the idea has come to be so generally realized that the plan has its advocates in almost every community. At the end of December 1936, there were 466 city and county managers employed. This means that more than one in every five United States cities of over 10,000 population was operating under the plan. Seven counties were so operating—three in Virginia, two in California, one in North Carolina, and one in Nebraska. And there is a growing interest in it everywhere—in places ranging in size from 1,000 to millions, from Eastport, Me., to Seattle, Wash. Philadelphia has recently become very much interested, as has Chicago. New York also likes the idea, and feels that it ought to be operating under some similar plan.

Table I shows the year-to-year increase in council managerships, beginning in 1908 with Staunton, Va. Their distribution, by states, in 1937, is given in Table II. Cities outside the United States having council-managers number 19. There are 14 in Canada (10 in Quebec, 2 in Ontario, 1 in Alberta, 1 in New Brunswick), 4 in Ireland, and 1 in Puerto Rico (San Juan).

ENGINEER MANAGERS PREDOMINATE

An "occupational classification," including some 863 persons who are or have been managers, has been compiled by Leonard D. White, Professor of Public Administration, University of Chicago, and printed in his book, *City Manager*. By far the largest number of men from a single occupation (398) are classified under engineering. The next largest number are listed as "business," or "executive class," of which there are 103. Among the other classifications are educators, 15; lawyers, 16; U. S. Government officials, 6; county officials, 16; journalists, 4; state government officials, 3; city employees and department heads, 67; and secretaries, 14.

According to Mr. White, "It is safe to assert that few [of the men represented by the preceding groups] received any systematic grounding in municipal government or in governmental problems in general. It can hardly be doubted that if these men had been given a solid course in municipal government and administration in their preparatory days, they would be able to deal with the phases of city problems more effectively."

Table I. Growth of the Council-Manager Form of Government

Year	Council Managers	Year	Council Managers
1908	1	1924	276
1912	4	1925	299
1913	12	1926	317
1914	31	1927	338
1915	51	1928	354
1916	64	1929	370
1917	79	1930	388
1918	102	1931	406
1919	128	1932	424
1920	160	1933	433
1921	207	1934	444
1922	235	1935	463
1923	264	1936	466

It is a recognized fact that already the greater number of councils that make manager appointments favor the civil engineer, or the man who, although not necessarily labeled "engineer" at that specific time yet has had an engineering background and experience. The majority of the charters state that "The manager shall be chosen by the council solely on the basis of his executive and administrative qualifications, preference in making said appointment to be given to a duly qualified civil engineer when possible."

The charter frequently states that the manager must be at least thirty years of age, although there are several successful young managers who are under thirty. These are in most cases in the smaller cities. Larger cities generally feel that only a more mature man will have the decisiveness, character, and general administrative ability which this work demands. The average age for a man to enter the profession is 36 to 40.

The duties of the council-manager, as set forth in most charters, include the following:

To see that all laws and ordinances are enforced.

To exercise control over all departments, and to appoint, supervise, and remove department heads and subordinate employees of the city.

To make such recommendations to the council concerning the affairs of the city as may seem desirable.

To keep the council advised of the financial condition and future needs of the city.

To prepare and submit to the council the annual budget.

To prepare and submit to the council such reports as may be required by that body.

To keep the public informed, through reports to the council, regarding the operation of the city government.

TABLE II. DISTRIBUTION OF COUNCIL-MANAGERS BY STATES

Arizona	2	Maine	17	Ohio	23
Arkansas	1	Massachusetts	4	Oklahoma	29
California	35	Michigan	46	Oregon	6
Colorado	5	Minnesota	5	Pennsylvania	20
Connecticut	3	Missouri	3	South Carolina	4
Delaware	2	Montana	1	South Dakota	3
Florida	37	Nebraska	1	Tennessee	5
Georgia	15	New Jersey	7	Texas	37
Illinois	6	New Mexico	4	Vermont	7
Iowa	10	New York	14	Virginia	41
Kansas	16	North Carolina	19	West Virginia	6
Kentucky	5	North Dakota	1	Wisconsin	7

The council-manager plan of municipal government has practically the same organizational set-up as that of an up-to-date corporation, a fact which adds to its professional appeal. The citizens (stockholders) vote for a representative group of men for the city council (board of directors), and the council in turn hires a city manager (general manager) to run the city's business. The city manager is of course responsible to the council. Opportunity for advancement—in the form of an increase in salary, a position in a larger city, or an outstanding opening in another field—comes to the council-manager from doing a good job in the city where he is.

THE MANAGER AND THE PUBLIC

Local citizens' clubs can be of great value to the city manager in his efforts to effect adoption of new civic programs, and he usually becomes a member of a civic organization, such as the Chamber of Commerce, and of a service club, such as the Rotary Club. In some places the manager is appointed secretary of the Chamber of Commerce.

The press is also a means towards helping to assure public favor for the council-manager's policies. At the outset, the press makes public the story of his appointment, his previous connections, his education, and his affiliations. Soon his appointments, removals, and reports, and any pertinent information he gives out, are in the newspapers for all citizens to read. Of course the good manager shows only a courteous and cooperative attitude toward the press and is partial to no particular publication.

It is not in accord with the theory of the council-manager plan that the manager should become a community leader. However, with his knowledge of the day-to-day workings of the community, he has a certain position of leadership whether he is aware of it or not. The engineering improvement project he plans becomes "his" project, and a given policy he deems advisable for the solution of a particular problem becomes "his" policy. It goes without saying that he should not in any way participate in political campaigns; nor should he advocate or defend policies that are likely to become subjects of party controversy.

The manager must be prepared very frequently to accept invitations to speak. The people want to hear the man who has the city's affairs always at his fingertips. Although few managers are public speakers at the time of appointment, they constantly develop and improve this faculty in the course of their work.

A PLAN FOR JOINT MANAGEMENT

In Maine a proposal was made, for consideration of the 1937 session of the legislature, that two or more towns be permitted to unite in the employment of the same manager. The bill was defeated there this year, but there are some places in other states where the idea is already working, and seems to be very satisfactory. Under such a system the councils of adjoining or nearby municipalities arrange to hire a manager who is to divide his time between them and whose compensation is to be made up in proportional amounts agreeable to them; this gives him an attractive salary. His office expenses, according to the Maine bill, are also to be paid proportionately by the towns. His basic powers and duties as set forth in this article read:

Said manager shall keep the accounts of each town separately and make separate reports to each town.

He shall keep full and complete records of the doings of his office and render an itemized monthly report in writing showing receipts and disbursements for the preceding month.

He shall have charge, control, and supervision of the following matters:

The management of municipal water works, lighting, and power systems.
The construction, maintenance, and repairing of all town buildings, and of all town roads, highways, sidewalks, bridges, except as otherwise specifically voted by the town.
The purchase of all supplies for the town, excepting supplies for the schools.
The police and fire departments of the town.
The system of sewers and drainage.
The lighting of streets, highways, and bridges.
The sprinkling of streets and highways and the laying of dust and removal of snow.
The maintenance of parks, commons, and playgrounds.
The care of cemeteries.
The letting, making, and performance of all contracts for work done for the town.

Further:

He shall administer the poor relief of the town, either directly or through a person or persons appointed by him.

He shall act as and perform the duties of health officer.

He shall be and act as tax collector.

It is also provided that when a town has become a member of such a union of towns, withdrawal shall become effective only at the end of the term for which the manager was employed. He is chosen for a term of not more than three years, and may be discharged only after due notice, investigation, and a public hearing.

It seems evident that in this growing profession of municipal management, more and more civil engineers are going to be abe to find the opportunity for personal advancement and the chance to make themselves outstanding in their community lives through rendering valuable public service.

Anchorage of Mill Roofs

Wind-Storm Damage May Be Minimized by Connections of Ample Strength

By H. A. Sweet *and* R. C. Corson

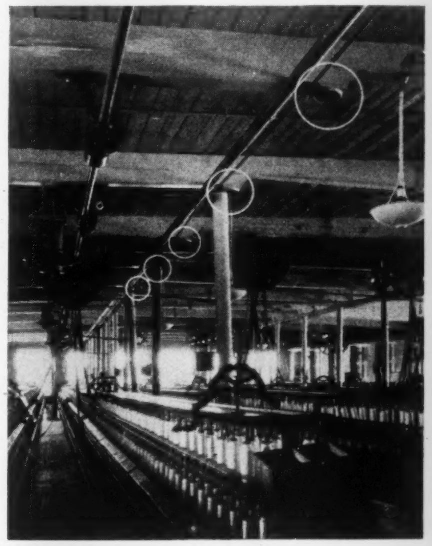
Engineers of the Associated Factory Mutual Fire Insurance Companies, Boston, Mass.

INTENSE cyclonic disturbances sometimes play strange pranks with buildings in their paths. Although the high-velocity, vortical winds of these storms are more or less irresistible, they cover a limited field, whereas the strong winds blowing inward from all directions may affect buildings over a very large area. The destruction wrought by tornadoes and wind squalls can therefore be greatly reduced at a very small cost, as Mr. Sweet and Mr. Corson point out in the accompanying article, by providing sufficient anchorage for the roofs of mills and other structures in tornado districts to resist such straightaway winds only. Practical means for securing connections of ample strength are suggested, and a number of popular misconceptions regarding the action of high winds on buildings are dispelled.

WIND effects on buildings have received much study during recent years. Pressures above and under the roofs of a few typical buildings, produced by wind at varying angles, have been determined in this country by the U. S. Bureau of Standards, several technical schools, and a few industrial concerns, and abroad by a number of investigators. The results have been sufficiently in agreement to remove any question of their reliability. (See the series of eight articles on "Aerodynamics and the Civil Engineer," by W. Watters Pagon, M. Am. Soc. C.E., in *Engineering News-Record*, beginning March 15, 1934, and ending October 31, 1935; the U. S. Bureau of Standards Research Paper No. 301; and the Progress Report of Subcommittee No. 31, Committee on Steel of the Structural Division, on Wind Bracing in Steel Buildings, March 1936 Proceedings of the Society.) Of the various forms of investigation, wind-tunnel tests on model buildings are probably of the greatest value.

In view of the innumerable types of buildings constructed today, it has been impossible to determine the effects of wind on any large number. However, the great future advances which are to be expected in this field will aid in designing new buildings and in strengthening existing ones. The previously mentioned Subcommittee on Wind Bracing in Steel Buildings, formed to study all available test data, has made most commendable progress during its relatively few years of existence. So far, the results of these tests have been disquieting, as they indicate the incorrectness of conventional methods for computing downward wind loads on roofs of slight and moderate pitch and horizontal wind loads on walls. Extensive further research and study of wind-storm damages are needed to determine wind loads on buildings with accuracy.

In designing roofs for new industrial buildings or anchorages for existing roofs, consideration should be given to the type of storm to which the building may be subjected, whether a severe or moderate hurricane, a tornado, or a thunder-squall; to the exposure or sheltering of the building; the interior pressure; the susceptibility of the building's contents to structural or water damage; and to the weight of the roof and the strength of its fastenings.



This Roof, Unanchored at the Center, Was Raised by a Violent Wind-Storm, Although Well Anchored at Walls

Two of the Columns Fell. If the Roof Had Been Raised a Little Higher, It Would Probably Have Collapsed

Proper selection of wind loads for roof design requires a knowledge of the probable forces corresponding to the various wind velocities. The 5-minute average velocities reported by the U. S. Weather Bureau stations do not show the velocities of gusts, the maximum value of which may last only a second or less, although it would be very helpful to engineers if such instantaneous velocities were reported. Pending such information, the curves shown in Fig. 1 may be of general use in estimating wind loads. As this figure is based upon recorded velocities for limited periods of time only, stronger straightaway winds may well occur in the future. To select a reasonable velocity for design purposes, careful study is recommended of maximum velocities over a long period of years in the location under consideration. Such a study for Baltimore is reported in the May 9, 1935, *Engineering News-Record*.

Damage to roofs and walls, followed by damage to contents from rain water, broken sprinkler pipes, or falling debris is sufficiently extensive to make wind-storm insurance essential. As an indication of the extent of wind-storm losses and the need for improvement in building construction, the Associated Factory Mutual Fire Insurance Companies, for the five-year period 1932–1936, experienced 2,232 wind-storm insurance claims totaling $1,777,440, from an average of about 7,800 mills. The largest items in these claims are shown in Table I. Such losses, which are doubtless typical of wind-storm insurance in general, nevertheless probably represent not over 10 per cent of the total wind-storm damage in the United States and Canada.

Tests indicate that a number of conceptions regarding the action of wind on buildings which have been common for many years are contrary to actual conditions. For example, it was generally believed that damage to roofs without overhanging eaves was caused by wind entering broken or open windows or doors on the windward side and building up a pressure inside which forced up the roof. Wind-tunnel tests show conclusively, however, that when wind blows perpendicularly to the side of a building, suction exists over the roof and on the outside of all but the windward walls. Such suction is properly called a negative pressure, since it is less than the pressure existing when the air is motionless.

For very strong straightaway winds, not tornadoes or hurricanes, the upward force over large areas of the main roof may be as much as 30 lb per sq ft, and over limited areas in certain parts of the main roof and over monitor roofs, perhaps 45 lb per sq ft. Severe hurricanes may produce forces 10 to 15 per cent higher. Even though windows may be sufficiently tight to exclude the force of relatively instantaneous gusts, the original pressure inside the building may be sufficient to force up unanchored roofs in the presence of negative pressure over the roof. This condition is especially apt to occur with light plank or corrugated iron roofs. Of course, if a few windows or doors happen to be open on the windward side of the building, the tendency of the roof to lift is even greater. On the other hand, if the windows on the windward side of the building are all closed, and some of the leeward ones are open, the lifting tendency of the roof is decreased.

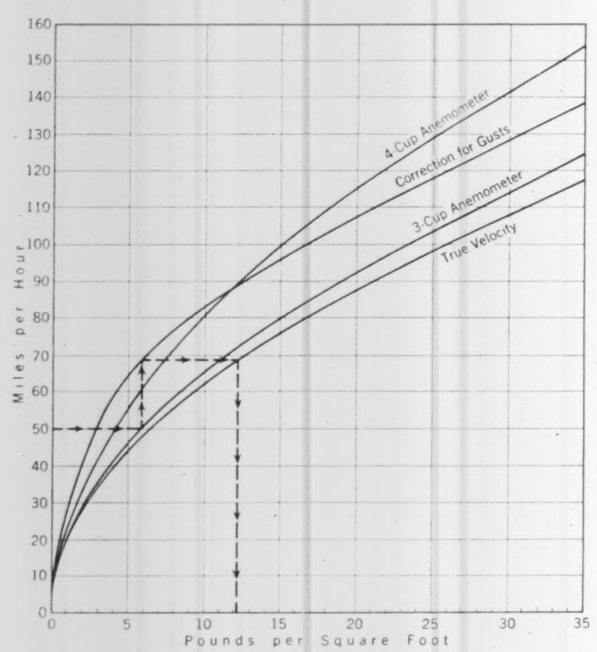


FIG. 1. CHART FOR OBTAINING TRUE VELOCITIES AND PRESSURES OF INSTANTANEOUS GUSTS FROM WEATHER BUREAU WIND RECORDS OF MAXIMUM AVERAGE VELOCITIES FOR 5-MIN. PERIODS

The Dotted Line Indicates That a 50-Mile Wind, as Recorded by a 3-Cup Anemometer, Will Probably Be Accompanied by Gusts of 69 Miles per Hr, Exerting a Pressure of 12 Lb per Sq Ft

TABLE I. CLASSIFICATION OF WIND-STORM INSURANCE CLAIMS

PART OF BUILDING DAMAGED	CLAIMS		AMOUNTS	
	Number	Per Cent	Dollars	Per Cent
Roofs and roof anchorage . .	218	9.8	$923,019	51.9
Roof covering	637	28.5	301,815	17.0
Windows and skylights . . .	503	22.5	147,598	8.3
Walls	58	2.6	118,030	6.6

Another exaggerated conception has to do with the effect of upward forces on windward eaves, as tending to lift the edge of the roof. Wind-tunnel tests show that even without any eaves, and with all windows and doors tightly closed, there are very strong upward forces on the roof, and indicate that eaves may exert a maximum force of only about 45 lb per sq ft. A parapet 2 or 3 ft high does not prevent damage to a roof covering or a roof subjected to very strong winds, but is of some value in increasing the anchorage furnished by the walls to the ends of roof beams recessed into them.

ROOFS SHOULD BE SECURELY ANCHORED THROUGHOUT

In many southern mills, the roof beams are well anchored to the walls and to the tops of the interior columns, but the bases of the columns are not fastened to the floor beams below. Now unless the bottoms of the columns are also fastened, there is no assurance that the roof will not rise sufficiently to pull the side walls into the top story, as indicated in Fig. 2. Suggestions for secure anchorage are shown in Fig. 3. Other equally effective construction details can be designed to meet local requirements.

Roof joists are nearly always merely toe-nailed to supporting timbers or trusses. Such fastening is adequate for downward loads but not for large upward ones, and the roof is apt to lift up during very strong winds. A contributing factor in such losses is the occasional use of insufficiently seasoned boards, which shrink around the nails, or warp and pull up from the roof framing after a few years. Whenever the roof covering is renewed, it is advisable to renail the boards.

A large number of wind-storm losses involve prepared or built-up roof coverings such as metal and asbestos-cement sheets and various kinds of tile. Loading of test panels built of such materials with sand or by other methods is inexpensive, and would indicate any changes which may be needed in the materials or in their fastenings. Fastenings that are easily installed in the correct manner should be used as much as possible, in order to reduce the dangers from poor workmanship.

Heads of rivets in riveted straps around channels, angles, or joists sometimes pull through corrugated-iron roof sheets in strong winds. The rivet heads are frequently too small or the rivets are poorly driven, and water may rust the sheets around their shanks, enlarging the holes. A method of providing additional wind-storm resistance for existing corrugated-iron roofs is shown in Fig. 4. For new construction, 18-gage galvanized metal straps, $^3/_4$-in. wide, should be spaced 12 in. apart at the tops and bottoms of the sheets, and 24 in. apart at intermediate supports. It is not satisfactory to nail corrugated or flat sheet-metal roofing to wood; if bolted straps cannot be used, an external pipe anchorage can be installed on existing buildings subject to severe winds, if values warrant. The use of clips for fastening sheet-metal roofing is not recommended, as these are usually of thin metal and are apt to bend rather easily, losing their hold on channel flanges or angles. Fire-retarding and corrosion-resisting treated corrugated-metal sheets, although light in weight, are less frequently damaged by wind-storms, as greater care is usually exercised in the design and use of bolted fastenings.

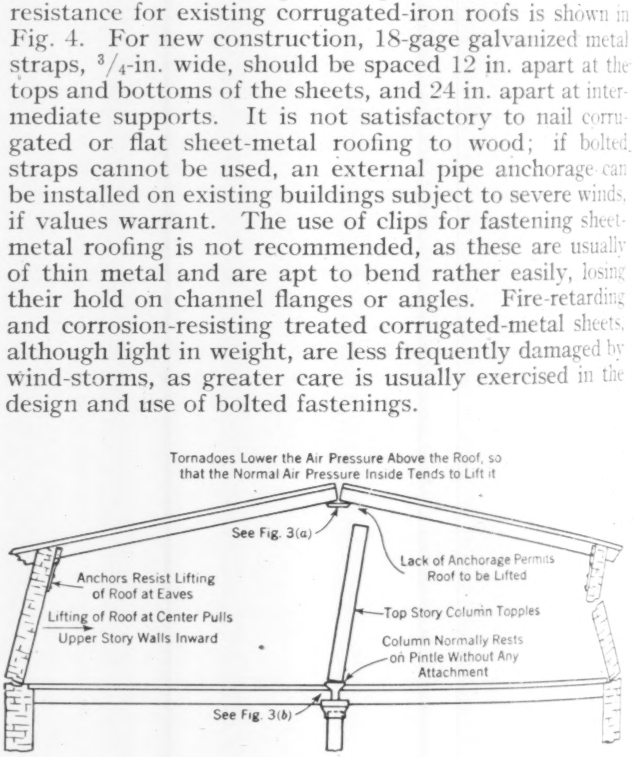
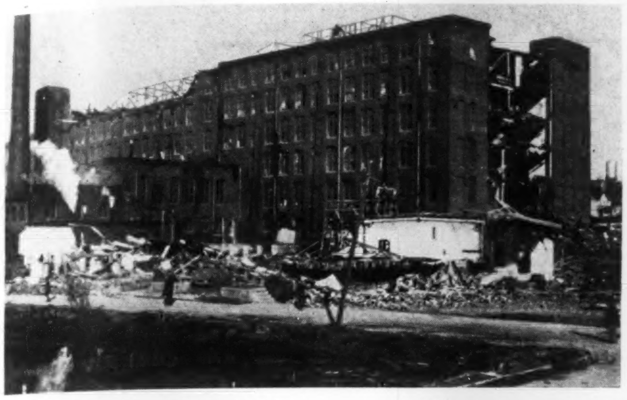

Tornadoes Lower the Air Pressure Above the Roof, so that the Normal Air Pressure Inside Tends to Lift it
See Fig. 3(a)
Lack of Anchorage Permits Roof to be Lifted
Anchors Resist Lifting of Roof at Eaves
Lifting of Roof at Center Pulls Upper Story Walls Inward
Top Story Column Topples
Column Normally Rests on Pintle Without Any Attachment
See Fig. 3(b)

FIG. 2. DIAGRAMMATIC SKETCH SHOWING PROBABLE ACTION OF A VERY STRONG WIND ON THE TOP STORY OF A MILL WHERE THE ROOF IS INADEQUATELY ANCHORED ON COLUMN SUPPORTS

Sheets of corrugated or flat asbestos cement are fastened best by clamps, as shown in Fig. 5, or by other adequate details. Nails or drive-screws should not be used in this material. If applied over wood, 3-in. or 4-in. wood screws are advised, with lead and galvanized-iron washers and waterproofing compound flashings. Edges of the sheets should be well bolted together.



Northeast Corner of a Mill Struck by a Tornado Coming from the Southwest

A Large Portion of the End Wall and the Windows in the South and East Walls Were Blown Outward

Steel-deck roofs consisting of thin sheets of metal with insulation and waterproof coverings need very effective anchorage because of their extremely light weight. The use of obsolete clips for securing the deck to the purlins and of staples for fastening together layers of insulation should be avoided. The spot-welding of clips or roof sheets to steel purlins is generally advisable, while thorough and careful mopping with asphalt provides an effective bond between various layers of insulation and between the deck plates and the adjacent layer.

Many light types of roof tile and pre-cast slabs are installed without sufficient provision for effective anchorage. Extremely light decorative tile is used rather extensively in southern states where snow is not a factor but where hurricanes produce severe wind hazards. It is recommended that tests be conducted on such construction and improved anchorage developed where needed or else that its use be discouraged where there is valuable property susceptible to damage by rain. Even cement tile weighing 16 lb per sq ft is not sufficiently heavy to resist severe winds. Such tile frequently has no anchorage. Use of external pipe anchorage, through bolts, spring clips, or wire ties is recommended.

A considerable amount of damage also occurs to tile coping on parapet walls. As such tile should have a more positive and durable fastening than the usual cement-mortar bond to smooth glazed surfaces, key anchors of tile or wire to be bedded in mortar or masonry, or the equivalent, are suggested.

Steel framing, consisting of steel trusses, beams, and columns, is usually well riveted or bolted together and is very seldom damaged by straightaway winds. However, the use of through bolts instead of lag screws for fastening nailing strips to steel channels or beams, and of adequate anchorage of steel supports to masonry walls are worth-while improvements. Reinforced-concrete buildings have been relatively free from damage, except to their roof coverings.

Information is needed regarding the effectiveness of the nailing of most types of roof coverings and the strength of the covering material itself after several years' exposure. Wind-storm losses from this source, involving leakage of rain water into buildings, is large. It is possible that entrapped air is present under many types of coverings, as sometimes evidenced by blisters, and exerts large upward forces when negative air pressure exists over the roof. If shrinkage openings occur between roof planks or boards, the air pressure in the top story of the building, being greater than that on the outside of the roof, will increase the tendency of the covering to lift. In one case, four-ply tar and gravel roofing was partially torn off and extensively loosened by a wind with a velocity of 60 miles per hr. The covering was only three years old, guaranteed for ten years, and apparently in good condition. Close spacing of nails, and the use of splined roof planks and ship-lap boards is advisable. Drying out of oils from asphaltic materials makes occasional remopping necessary, and flashings and edging strips require regular maintenance.

Sheds with louvre slides, such as those used for tobacco-storage, need substantial anchorage, including fastening the columns to the concrete piers, longitudinal bracing in the walls, and knee braces from beams to columns. The louvred part of the windward side of the wall apparently furnishes as much resistance to wind as would a solid wall. Sheds without walls doubtless have small upward forces under the roof, but if there are adjoining buildings on the leeward or the windward side, extending up to the roof of the shed, or if large areas of material in the shed are exposed, upward forces of appreciable magnitude may tend to lift the roof.

ACTION OF TORNADOES

Tornadoes occur mostly in the central part of the United States, but they may be expected occasionally over a considerable part of the more densely populated sections of the country. They are usually considered so violent as to preclude the possibility of providing sufficient strength to prevent structural damage, and it has sometimes even been suggested that good anchorage of the upper stories of a mill would result in lifting more of the building than if the roof were not anchored. Very low barometric pressures occur in and near the spinning vortex of a tornado, resulting in the blowing out of walls and windows of buildings, as happened in the case of the building shown in one of the photographs.

Here the northeast end-wall was apparently weaker than the roof, which blew off only in part. The

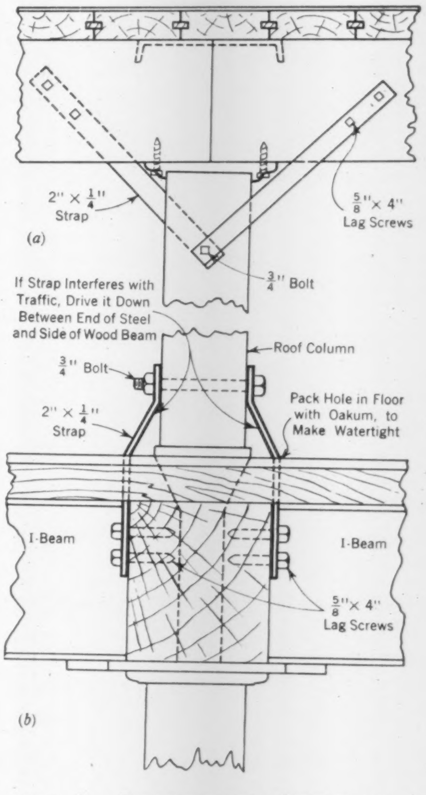

2" × 1/4" Strap
5/8" × 4" Lag Screws
(a)
3/4" Bolt
If Strap Interferes with Traffic, Drive it Down Between End of Steel and Side of Wood Beam
Roof Column
3/4" Bolt
Pack Hole in Floor with Oakum, to Make Watertight
2" × 1/4" Strap
I-Beam
I-Beam
5/8" × 4" Lag Screws
(b)

Fig. 3. Recommended Anchorage Details at an Interior Column in the Top Story of a Mill Building

(a) Detail at Roof (b) Detail at Floor

roof beams were anchored to the side walls. It is probable that there was an aisle at the damaged end of the building and that the floor planks in the end bay were not heavily loaded, although spiked to a wall beam. This beam was probably not anchored to the thin unloaded end wall, and offered little resistance to blowing out of the wall, whereas the corner toilet tower and dust flue tied the side panels of the end wall effectively to the side walls, which were not damaged structurally. The building is 528 ft long, and the collapsed end wall was at its leeward end.

On the roof, the greatest damage was done to the windward end. Apparently the roof lifted sufficiently for the roof beams to pull in the side walls to which they were anchored. The columns were not anchored to the floor framing below, and when some of the roof blew off, the top floor became in effect the roof of the building. This may explain why some of the lower-story floors lifted partially off of a few column cap plates. The large internal pressures were apparently more effective in lifting parts of floors, even though loaded, than in pushing out the thick side walls. At the windward end of the building, the external pressure tending to force the wall inward was probably greater than the internal pressure tending to force the wall outward. This force was resisted by the floor planks, and the wall did not fail.

The velocity of the rotating vortex of a major tornado is probably several hundred miles per hour. This is more or less irresistible, but the area it covers is limited, being usually a strip from 300 to 1,200 ft wide and seldom over 25 miles long. However, there are straightaway winds of strong intensity for many miles in all directions, rushing in towards the vortex, which may damage inadequately anchored buildings, and more buildings are thus subjected to straightaway winds than are within the vortex. Experience tends to indicate, therefore, that the destruction wrought by tornadoes would be greatly reduced by anchoring roofs as described.

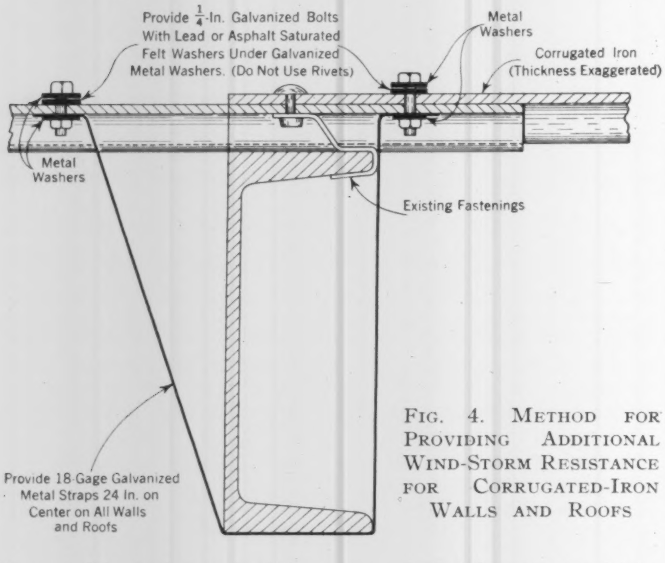

Provide $\frac{1}{4}$-In. Galvanized Bolts With Lead or Asphalt Saturated Felt Washers Under Galvanized Metal Washers. (Do Not Use Rivets)
Metal Washers
Corrugated Iron (Thickness Exaggerated)
Metal Washers
Existing Fastenings
Provide 18-Gage Galvanized Metal Straps 24 In. on Center on All Walls and Roofs

FIG. 4. METHOD FOR PROVIDING ADDITIONAL WIND-STORM RESISTANCE FOR CORRUGATED-IRON WALLS AND ROOFS

VALUE OF PRESSURE-VENTING WINDOWS

It has sometimes been suggested that upon approach of a tornado, windows be opened to relieve the internal pressure in the building. From the owner's standpoint, however, this opens the way to possible large damage from rain to contents of the building. (Such damage is not covered by wind-storm insurance unless the building is broken open by the wind.) It would be unlikely that the judicious opening of windows only to the leeward could be controlled effectively. It has also been suggested that roof hatches be installed, designed to lift off and relieve the internal pressure. But even if the hatches lifted off as intended, they would not relieve the internal pressure in the lower stories. Furthermore, there might be difficulty in designing them to lift off reliably when appreciable reduction in barometric pressure occurs during a tornado, yet stay closed during the many strong straightaway squalls when there are also negative pressures over the roof. In addition, there would be undesirably large water damage to some occupancies. After consideration of various methods, and pending further experience and tests, the installation of approved "explosion-venting" windows is suggested as a helpful expedient. These should be of the horizontal top-pivoted type, providing 1 sq ft of venting window area per 100 cu ft of volume in the building.

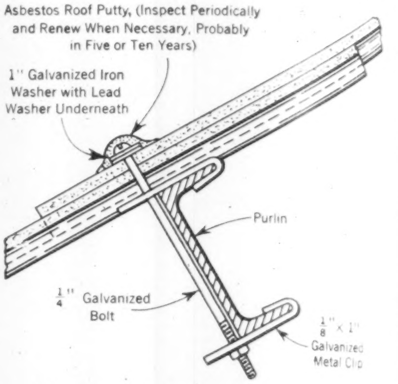

Asbestos Roof Putty, (Inspect Periodically and Renew When Necessary, Probably in Five or Ten Years)
1" Galvanized Iron Washer with Lead Washer Underneath
Purlin
$\frac{1}{4}$" Galvanized Bolt
$\frac{1}{8}$" × 1" Galvanized Metal Clip

FIG. 5. RECOMMENDED FASTENING FOR CORRUGATED ASBESTOS ROOF

Bolts to Be Spaced 12 In. Apart, at the Top of Corrugations; Side Laps to Be Bolted Every 18 In.

Existing standard center-pivoted windows can be made suitable by replacing positive latches with special spring-friction types of explosion-venting latches set to open at internal pressures of about 20 lb per sq ft. Of course, larger areas of venting may be needed than the existing windows provide. Curved wire screens can be installed around the exterior of such windows in first stories or where it is important to prevent the entrance of unauthorized persons. As wind forces are doubtless slower acting than explosive forces, the type of latches and stops which holds the windows open and prevents them from rising violently would seem to be unnecessary. In a recent case, explosion-venting windows of the general type recommended prevented serious damage to walls and roofs of a building subjected to an internal explosion of wood-flour. It should be noted that windows which remain open after operation, leaving the upper part of the window open to the weather, should not be used on account of the rain damage which usually results.

The top-story lateral resistance necessary for brick multi-story wall-bearing buildings exposed to violent storms, can be provided by special design. The use of steel for roof beams and top-floor beams and columns, exterior steel columns encased in the walls, and strong, rigid column and beam connections will provide a top story of rigid construction capable of resisting effectively the lateral-bending, lifting, and twisting forces developed.

With reference to the total cost of providing suitable wind-storm anchorage for roofs of existing buildings, the following are actual costs of engineering design and supervision, as well as installation costs. For plank-on-timber construction, a cost of about 2.7 cents per sq ft of roof area, and for joisted tobacco sheds, about 1.0 cent per sq ft, exclusive of additional concrete for column piers in one-story buildings if existing footings are of insufficient weight. Such costs are negligible compared to the savings to owners and insurance companies which may be expected from taking the necessary precautions.

Buildings Have Pulses

Modern Methods for Analyzing and Reducing Vibrations of Structures

By Jacob J. Creskoff
Consulting Engineer, Philadelphia, Pa.

Every building or other structure vibrates to greater or lesser degree under the action of impressed forces, in periods which depend upon the physical characteristics of the structure and its site. These vibrations are usually of such low amplitude and frequency that they can be detected only by use of a sensitive vibrograph. But when the period of the actuating force corresponds with the natural or dominant period of vibration of the building, the movements of the latter may become noticeable and even quite alarming to its occupants, although rarely dangerous structurally. Such dominant periods may be discovered by examining vibrograph records of the movements induced in the building by a shaking machine capable of producing impulses of widely varying frequencies. In cases where a building vibrates in more than one direction at the same time, tridimensional vibrograph records assist in analyzing its movements and tracing the source of the trouble, so that remedial measures can be taken. An interesting general discussion of the problem is presented by Mr. Creskoff in the accompanying article.

Buildings are practically always in a state of vibration induced by the action of internal or external forces, which may be caused by unbalanced operating machinery, elevators, wind gusts, motor traffic, subway or railroad trains, or earthquakes. No matter how tall and "flexible," or how low and "rigid" the building, it vibrates at pulse rates peculiar to itself. These pulse rates or frequencies of vibration (and their reciprocals, known as periods of vibration) depend on the physical characteristics of the building and its site. That is to say, the period of vibration of a building is a function of the type of ground on which the building is located, its dimensions, loading, materials of construction, strength, and rigidity.

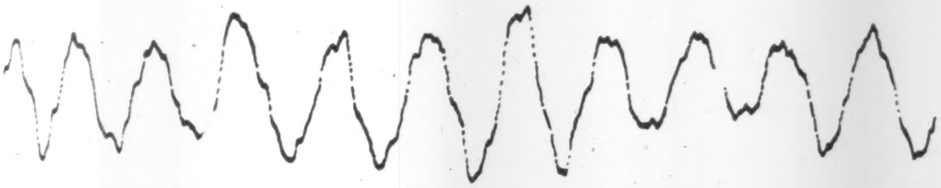


Fig. 1. Vibrations of the Washington Monument

Except during earthquakes, building vibrations ordinarily have a range of motion of the order of only 0.001 in. Hence they are not felt—in fact, they are detectable only by sensitive vibrographs. If, however, the period of the actuating force is equal to that of the building, the phenomenon called synchronism occurs. Just as resonance in music causes increased sound intensity, so synchronism in buildings results in an abnormal increase in the extent of motion, or amplitude.

During synchronism, therefore, a building vibrates through a relatively appreciable range of motion. These vibrations are not only great enough to be felt, they may even be alarming; but rarely, except during earthquakes, do they attain such magnitude as to become structurally dangerous.

It is not suggested that only synchronous vibrations are troublesome. A non-synchronous force, if sufficiently large, will also produce sensible vibration in a building. A synchronous force, however, is much more effective in exciting vibration, and its magnitude need be only a fraction of that of a non-synchronous force to produce the same effect. In order to determine the reason for excessive vibration and to arrive at an efficient and economical solution, it is accordingly essential to study the relationship between the period of the impressed force and the dominant periods of the building and its structural elements.

The vibrations of structures are measured and recorded by specially adapted seismographs or vibrographs. For example, the vibration of the Washington Monument, at the 500-ft level, caused by wind gusts with velocities of from 20 to 30 miles per hour, is shown in Fig. 1. Here two dominant modes of vibration may be identified—one with a period of 1.81 sec and an amplitude of 0.0005 in., and the other with a period of 0.60 sec and a much smaller amplitude.

Unfortunately, not all records of structural vibration caused by wind are as definite as that shown in Fig. 1. Sometimes the record is complex and difficult to analyze. In such cases the dominant periods of a building may be obtained by recording the vibrations induced by a shaking machine.

CONSTRUCTION OF A SHAKING MACHINE

A common form of shaking machine consists of two shafts carrying three circular steel plates, to which are bolted lead plates where required to produce unbal-

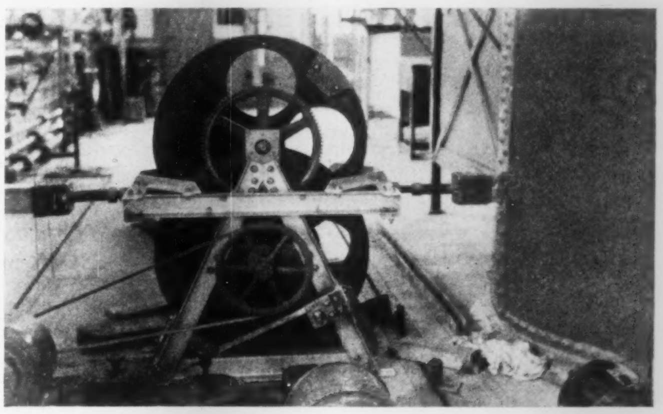


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Fig. 2. Shaking Machine Braced for Vibration Test

anced moments (Fig. 2). During operation, the forces developed are directly proportional to the unbalanced moment. The relationship may be expressed by the formula,

$$F = \frac{Wrw^2}{g}$$

in which F = centrifugal force, in pounds
W = weight of lead plates, in pounds
r = radius to center of gravity of lead plates, in inches
Wr = unbalanced moment, in inch-pounds
w = angular velocity, in radians per second
g = acceleration due to gravity, 386 in. per sec per sec

Two of the steel plates are attached to one shaft, and the third to the other shaft. The two shafts are geared together by cast-iron spur gears, and rotate in opposite directions. Equal unbalance is applied to each shaft. By this method, the centrifugal force F is confined in the plane directionally, as desired.

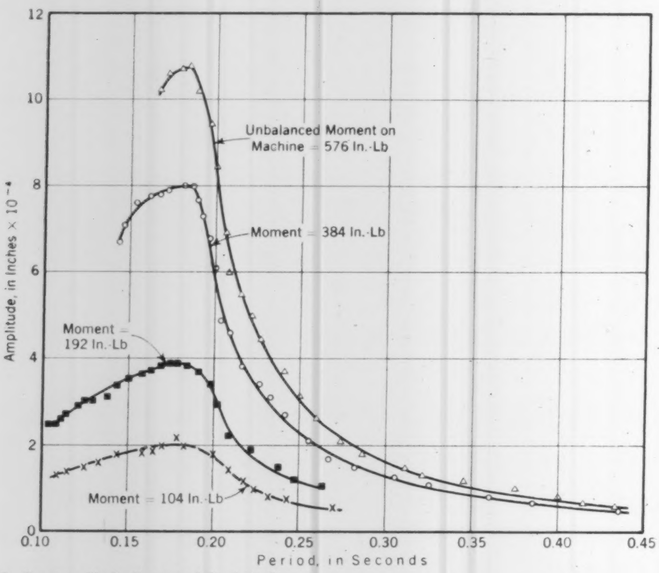

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FIG. 3. SYNCHRONISM CURVES FOR A "RIGID" REINFORCED-CONCRETE WAREHOUSE

The Large Amplitudes at 0.18 Sec Mark the Dominant Period

In use, the shaking machine is braced between rigid elements in the building to be tested. It is then driven directly by means of a direct-current motor and a V-belt, until the maximum desired number of revolutions per minute has been attained. The belt is then removed and the record of the vibration of the structure is taken continuously until the shaking machine comes to a stop. Examination of the record will then reveal the dominant periods of the building, for wherever the revolutions per minute of the machine correspond with the dominant periods of the building, abnormal amplitudes of synchronism are indicated.

In Fig. 3 are shown the synchronism curves for a "rigid," four-story, reinforced-concrete warehouse. Curves for four different unbalanced moments are given. The abnormally large amplitudes of synchronism indicate that the dominant period of the building is 0.18 sec. In Fig. 4 appear the synchronism curves for a relatively "flexible," 13-story and tower, steel-frame office building. Here again, the abnormal amplitudes of synchronism give the dominant period of vibration—in this case, 1.33 sec.

The elimination of excessive vibration involves human as well as technical considerations, and some knowledge of the vibration characteristics which most affect human sensibility and efficiency is required before it can be decided how and to what extent the vibrations should be altered. Otherwise an economical, or indeed an adequate, solution may not be obtained.

Personal observations of the layman concerning vibrations are often very misleading. In one case, for example, the vibration in a factory was so severe when the machinery was in operation that the personnel refused to work. They asserted that the building swayed an inch. This was decidedly at variance with the vibration records, which showed that the amplitude did not attain 0.10 in. Experience indicates that such observations are valueless for both physiological and psychological reasons. But, although in this case the vibrations were not dangerous structurally, it was obviously necessary to reduce them below the threshold of sensibility for the sake of the efficiency of the personnel.

ALLOWABLE LIMITS FOR VIBRATIONS

It has been shown by P. C. Constant, British aeronautical engineer, that vibrations are unfelt, or become sensible, as a function not only of the amplitude, but also of the period of vibration. To be in the "pleasant" zone, vibrations must have an amplitude not greater than 0.010 in. for a frequency of 700 per min, 0.007 in. for 1,000 per min, and 0.003 in. for 5,000 per min. In dealing with troublesome vibrations, therefore, it is only necessary to alter them so that they are below the threshhold of sensibility.

In investigating building vibrations, it should be kept in mind that the actuating force may be coming from any direction. It is therefore advantageous to record vibrations tridimensionally, that is, up-down, north-south, and east-west, preferably simultaneously. The direction and source of the troublesome vibration are determined by a study of the case data and the records.

It has been stated that structural vibration may be due to unbalanced operating machinery, elevators, wind gusts, motor traffic, subway or railroad trains, or earthquakes. Each of these factors operates in a characteristic manner through which it can usually be identified, and any one of them may be the cause of abnormal structural vibrations. Some, however, are apt to cause troublesome vibrations more frequently than others—for example, unbalanced machinery and railroad trains.

The solution in each particular case depends on the actuating force. If the vibrations are traced to wind action or earthquakes, then increasing the rigidity of the building may be the only cure. If the vibrations are caused by motor, subway, or railroad traffic, on the other hand, they may be corrected by insulating the building foundations from the ground. Where elevator operation is to blame, a change in equipment may be the answer. If unbalanced machinery is causing the trouble, the vibrations can be reduced by isolating and insulating the machinery from the building.

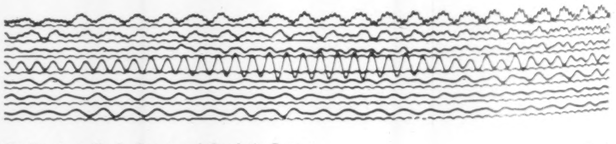

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FIG. 4. SYNCHRONISM CURVES FOR A "FLEXIBLE" STEEL-FRAME BUILDING. THE DOMINANT PERIOD IS AT 1.33 SEC

One interesting case involved an Atlantic City (N.J.) hotel, where excessive vibration made the guests very uncomfortable. Upon investigation, it was found that the actuating force was not due to traffic, surf action, elevator operation, or hotel equipment. Nevertheless, unbalanced operating machinery was clearly indicated on the records as the cause. The source was finally traced to a power plant in the vicinity. The vibrations of the plant's equipment, transmitted through the wet, sandy soil, were synchronous with one of the dominant periods of the hotel. After the plant machinery was isolated and insulated from the ground, the annoying vibrations ceased.

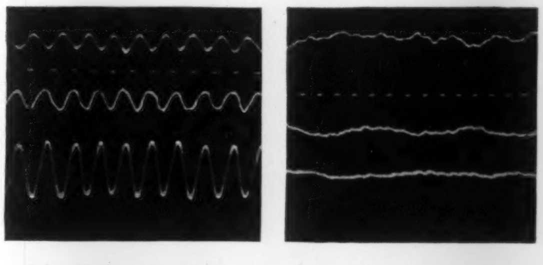

(*a*) Before Insulation (*b*) After Insulation

Fig. 5. Tridimensional Records of Building Vibrations

A few words about the free use of insulating material may be in order. To be effective, insulation must be designed specifically for the superimposed equipment or structure. The dimensions and the materials must be correct for the particular loading conditions. Otherwise, the unwanted vibrations may not only continue, but may be intensified, as some insulation enthusiasts have discovered. An explanation for this phenomenon may be drawn by analogy from the field of medicine. Here a minute dose of hydrochloric acid will not harm a cardiac patient, the correct amount will benefit him, and an excessive dose is guaranteed to make him uncomfortable.

In Fig. 5 are shown tridimensional records of building vibrations before and after unbalanced operating equipment was placed on an insulating mat. The reduction in the amplitude of the vibrations is readily apparent.

In addition to their usefulness in the elimination of structural vibrations, such records are also of value in cases where it is claimed that building damage is the result of the operation of railroads or unbalanced machinery, or of blasting operations during construction. By comparing successive vibration records, information may be obtained on progressive structural damage. Testimony based on such records, mechanical and impersonal as they are, enjoys a much higher standing in court than that based on personal judgment, and is ordinarily incontrovertible.

Another important use for vibration records is in connection with buildings in earthquake regions. After a major earthquake has occurred, it is important to determine quickly which buildings are safe for occupancy and which are not. Here again, comparison of the vibration records taken both before and after the earthquake furnishes information concerning the structural integrity of a building. This is because the change in period is related to the amount of damage—the larger the new period, the greater the damage. If, however, the periods of the building are unchanged, it is safe structurally, even in the presence of surface damage.

In conclusion, it may be said that buildings have pulses just like human beings. And just as a physician diagnoses his patient's condition with the help of the patient's pulse rate and intensity, so the structural and vibrational condition of a building can be determined by the aid of its periods and amplitudes of vibration.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Flow on Steep Slopes

By John Hedberg, Jun. Am. Soc. C.E.

Assistant Professor, Department of Civil Engineering, Stanford University, Stanford University, Calif.

Practically all our hydraulic theory on flow in open channels carries the proviso that flat slopes are assumed. Yet some of our most troublesome problems are concerned with chutes on grades of 10 to 30 per cent.

It is safe to say that problems of steep-slope flow are solved in general in one of two ways. Either we assume that the theory for flat slopes is sufficiently exact for practical purposes and design according to it; or, in recognition of the uncertainty of our theory, we build models to demonstrate the best design. Unfortunately, observations of flow on steep grades show that in many cases neither of these procedures is reliable. One might even go so far as to say that it is a dangerous practice to rely on either of them, were it not for the fact that our factors of safety are usually large enough to cover our mistakes. For the benefit of a clearer understanding of the peculiarities of this problem, I believe that a discussion of the subject is very much worth while.

In the first place, with regard to errors in theory, it is easily demonstrated that the pressure below the surface of a flowing stream is not equal to the product of density and depth below the surface, but is a function of the slope as well. Consider an element of a fluid of area *a* and thickness *dy*, as in Fig. 1. Assuming that flow is taking place parallel to the surface, we have equilibrium in the direction normal to the surface. Summing up the forces in this direction, we have:

$$a\,dy' \frac{\partial p}{\partial y'} = w \cos\theta \,(a\,dy')$$

Therefore $p = wy' \cos\theta$

If the vertical depth y is considered, we obtain

$$p = wy \cos^2 \theta$$

In any use of the Bernoulli equation, therefore, we should evaluate p/w as $y \cos^2 \theta$ instead of y.

As for the velocity head, it is obvious that it should be obtained by evaluating the velocity from $V = Q/A'$, where A' is the area normal to the flow, rather than from $V = Q/A$, where A is the area in the vertical plane. In other words, the velocity head should be $Q^2 / 2gA^2 \cos^2\theta$ rather than $Q^2/2gA^2$. Since the velocities are high for flow on steep slopes, the error resulting from the neglect of the slope term in the velocity head is even more pronounced than in the case of the pressure head.

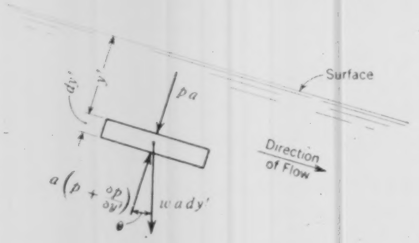


FIG. 1. FLOW ON STEEP SLOPE

Another factor of considerable consequence in flow on steep slopes is the velocity distribution. When the slopes are flat the distribution makes little difference, because the velocities are usually small; but when the slopes become large, neglect of the distribution factor may result in serious error. Although experiments are a bit variable in results, it seems clear that the true velocity head should be evaluated from $kV^2/2g$, where k is a factor in the neighborhood of 1.10, and V is the average velocity over the section.

How about model tests for flow on steep slopes? Why are they not reliable? The answer lies in the impossibility of simulating the phenomena of the entrainment of air. Perhaps it is an exaggeration to say that it is impossible to produce such similitude, but in view of the apparent complexities of the problem, it is at least highly improbable that it will ever be done. When we test a model of a spillway, therefore, we must not expect quantitative measurements; we can only hope that the results will be qualitatively in agreement with the prototypes.

In conclusion I would like to emphasize that flow on steep slopes is distinctly a different problem from that on flat grades. Either it should be treated as such, with the necessary refinements in theory, or the errors of the simpler theory should be recognized by increased factors of safety.

Figuring Length of Brace for Howe Truss

By RUSSELL CHASE, ASSOC. M. AM. SOC. C.E.

PORTLAND, ORE.

IN designing a Howe truss it is necessary to determine, accurately, the length of the diagonal. For this computation the following method is simple and direct.

The nomenclature is indicated in Fig. 1, h being the panel height, b its length, c the width of the diagonal brace, and a the length that is to be computed. (In Fig. 1 the panel length b is shown greater than the height h for convenience in lettering.) As the first step in the solution, find the value of θ that satisfies the equation:

$$h \cos\theta - b \sin\theta - c \cos 2\theta = 0 \quad \ldots\ldots\ldots [1]$$

As the second step, substitute this value of θ in the equation:

$$b \cos\theta - h \sin\theta - a \cos 2\theta = 0 \quad \ldots\ldots\ldots [2]$$

and solve for a.

This solution is based on the construction indicated in the diagram. The length OQ is equal to the required length a, and is the radius of a fixed circle, with center at O, inside of which a circle with radius $a/4$ rolls to generate the four-cusped hypocycloid $x = a \cos^3 \theta$, $y = a \sin^3\theta$. P is the tangent point, and QN the normal, and the side of the brace nearest to O is tangent to the hypocycloid at P. That portion of the tangent intercepted between the axes is also equal to a. The length of ON, the perpendicular from the origin to the normal, is $a \cos 2\theta$. Similarly, $O_1Q_1 = c$, and the length of the perpendicular from O_1 to the normal at N_1, is $c \cos 2\theta$. Also, $c_1 = c$, and $\theta_1 = \theta$.

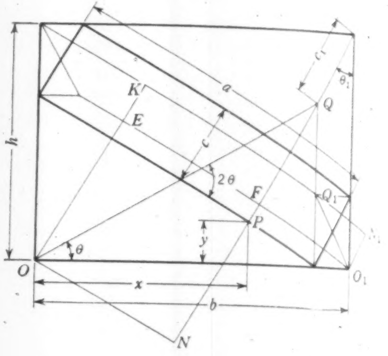


FIG. 1. PANEL OF HOWE TRUSS

In Equation 1, $h \cos\theta$ represents the length OK; $b \sin\theta$, the length OE; and $c \cos 2\theta$, the length EK. In Equation 2, $b \cos\theta$ represents the length O_1E; $h \sin\theta$, the length O_1F, and $a \cos 2\theta$, the length FE.

Short Cuts in Multiplying Feet and Inches

By GEORGE J. VIERTEL, JUN. AM. SOC. C.E.

CONSTRUCTION SUPERINTENDENT, M. SHAPIRO AND SON,
NEW YORK, N.Y.

IN changing feet to inches, I have found the following method much simpler and faster than the usual one of multiplying the number of feet by 12 and adding the number of inches to the product. To convert 17 ft 5 in. to inches, for example, multiply the feet (17) by 2 and add this product (34) to the 17 ft 5 in., as shown:

17 ft 5 in.
3 4
20 ⊃ 9 in. (that is, 209 in.)

If there are two digits in the inches, that is, 10 or 11 in., the 1 in the inch column must be carried to the foot column, after multiplying the number of feet by 2. Thus, if 19 ft 10 in. is the dimension, multiply the 19 ft by 2, and add the product, 38, to 20–0. The 20–0 is obtained by carrying the 1 of the 10 in. to the 19 ft so that the inch column only has one digit. The process in this case, then is:

19 ft 10 in., or 20 ft 0 in.
3 8
23 ⊃ 8 in. (that is, 238 in.)

The theory of this short cut is simple. It assumes each foot to be divided in two parts, of 10 in. and 2 in., respectively. The top line of the addition accounts for the 10-in. parts of the full feet, and for the odd inches. The second line accounts for the 2-in. parts.

Another useful short cut can be applied in multiplying feet and inches by feet and inches for finding areas. For example, let us multiply 2 ft 3 in. by 14 ft 5 in.:

	2 ft	3 in.
	14 ft	5 in.
	10	15
28	42	
28	52	15

The three columns are added independently, and the result is in three different units: 28 sq ft + 52 ft-in. + 15 sq in. Converting the 52 ft-in. to square feet (dividing by 12), we have 4 sq ft plus 4 ft-in. Changing the 4 ft-in. to square inches (multiplying by 12), we have 48 sq in. Hence the final result is:

28 sq ft	15 sq in.
4 sq ft	48 sq in.
32 sq ft	63 sq in.

The application of this principle is much simpler than may appear from the detailed explanation, for all the processes shown are really mental.

Getting Rid of Carbon Dioxide in Mono Craters Tunnel

By Adolph A. Cohan, Jun. Am. Soc. C.E.
Rodman, Stone and Webster Engineering Corporation, Los Angeles, Calif.

Unusual quantities of carbon dioxide have been encountered in one section of the Mono Craters tunnel, now under construction by the Los Angeles Bureau of Water Works and Supply near Bishop, Calif. The gas is a product of the volcanic action that occurred in the Mono Craters in bygone ages. Much of it is carried in the ground water and is liberated in the tunnel when pressure on the incoming water is released; however, it also enters through faulty rock sections and "gas springs" in the tunnel surfaces.

Carbon dioxide is, of course, not actually poisonous, though in concentrations of over 10 per cent it may cause dizziness, unconsciousness, or even death. Work can be carried on in an atmosphere containing 5 per cent of the gas, but even in this concentration it increases normal respiration 100 per cent, and causes the workers to tire more quickly. Hence it is desirable to hold the concentration to a minimum.

Figure 1 shows the ventilating system installed for this purpose. The ventilating shaft at the left of the drawing is about 11,000 ft from the west portal. The blower pipes are 18 in. in diameter. One of them is carried up to within 25 or 50 ft of the heading, and blows around 10,000 cu ft of air per min. A second pipe ends about 200 ft from the heading, over the California switch, and blows close to the same amount. A third terminates in the shaft itself (which is sealed off airtight at the top) and contributes about 4,000 cu ft per min. The fourth pipe ends under a wooden flooring, and is run on exhaust at about 4,000 cu ft per min. Most of the carbon dioxide collects under this floor (the concentration may be as great as 25 per cent) and is drawn off without ever getting into the tunnel proper; the rest is carried with the excess fresh air to the west portal.

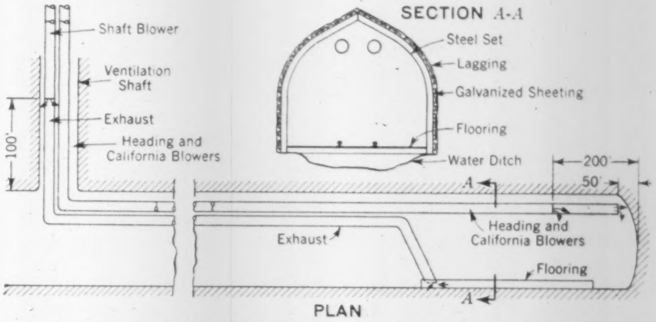


Fig. 1. Schematic Representation of Ventilation System, Mono Craters Tunnel

The Heading Blower Is Reversed, When a Round Is Fired, to Draw Out the Powder Smoke

Air samples are taken daily at various locations throughout the tunnel and analyzed for carbon dioxide and oxygen content. Samples of the water pumped from the tunnel are also tested for carbon dioxide. The total quantity of air pumped into the tunnel is computed from pitot tube readings taken at ports in the blower pipes, and the water discharge is also gaged. Hence the total amount of carbon dioxide removed from the tunnel can be computed. Approximately 100 cu ft per min is removed in the exhaust blower; another 100 cu ft per min is carried away in the water; and about 400 cu ft per min is blown out the portal with 20,000 cu ft of air.

Our Readers Say—

In Comment on Papers, Society Affairs, and Related Professional Interests

Practical Difficulties in Use of Arbitration

To the Editor: In the July issue Malcolm Pirnie, M. Am. Soc. C.E., in his article, "Arbitration Versus Litigation," presents the value of an arbitration clause in construction contracts as a means of settling controversies and thereby avoiding possible costly litigation and delays.

I am in complete accord with the ideals and motives underlying advocacy of arbitration in the various fields of human relationship and commend Mr. Pirnie's article to the attention and careful consideration of all engineers charged with the responsibility of preparing construction contracts and supervising work under those contracts.

During the past five years it has been my responsibility to supervise upward of twenty construction contracts of considerable magnitude, containing the following arbitration clause: "Any and all disputes arising under, out of, in connection with, or in relation to this contract or to the performance of or payment for the work hereunder, shall be submitted to arbitration under the rules of the American Arbitration Association." The contracts also contained the following clause quite common in construction contracts: "In case of any questions as to the meaning or interpretation of the plans and specifications, the decision of the engineers shall be final and conclusive."

Whether or not it was due to the presence of either or both of these clauses, the fact remains that the arbitration clause was invoked in only one instance. Throughout my professional career it has been my aim to have plans and specifications prepared in such a manner as to be truly complementary and to eliminate as far as is humanly possible the element of uncertainty in the preparation of bids. It is my belief that preliminary exploration and investigation should be made and paid for by owners so as to relieve bidding contractors from assuming unfair risks.

Although complimentary statements were made by bidders regarding the completeness of plans and specifications for the contracts herein referred to, the one contractor mentioned took occasion to question the decision of the engineers regarding certain designations on the plans and clauses in the specifications and, by advice of counsel, filed a claim under the arbitration clause. The claim was comparatively small in amount, and I doubt if this contractor would have taken his case to court. However, the presence of the arbitration clause in the contract enabled him at very little expense to "try it on."

Just how the arbitration board arrived at the amount of the award it is, of course, impossible to know. Some extra items appearing in the claim had been previously agreed to, and the board did not allow the full amount of the claim. But under the terms of the contract signed by both parties, and including the plans and specifications, the invoking of the arbitration clause was in my opinion unjustified as the claimant made no assertion or complaint that the party of the first part had in any way failed to comply with its obligations under the contract, and the award other than items conceded and agreed to was also, in my opinion, unjustified.

As before stated, I believe in the principle of arbitration as a way of avoiding expensive, time-consuming litigation, but the procedure to be followed under the contract and the qualifications of arbitrators should have very careful attention on the part of lawyers and engineers, either singly or jointly, who may be charged with the preparation of the form of contract.

R. T. BETTS, M. Am. Soc. C.E.
Chief Engineer, The Robbins-Ripley Company

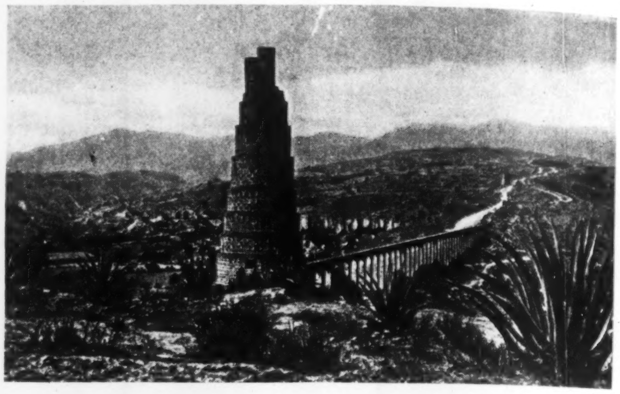
New York, N.Y.
August 5, 1937

Ancient Water Tower at Los Remedios, Mexico

DEAR SIR: The striking example of construction in old Mexico, shown on the Page of Special Interest in the May issue, might well have been headed, "Modern Engineering Design Is Not Without an Ancient Touch." Incidentally, the same heading would apply in comparing the modern skyscraper architecture with the "Casas Grandes" in northern Chihuahua.

I have visited the old water tower at Los Remedios several times. This tower, with its viaduct, represents engineering and architectural ability of a high degree, and records history at the most critical period of the Great Conquest. I have never been able to establish the date of its construction, but undoubtedly it was built soon after the Conquest and about the time of the building of the church of Los Remedios under the direction of Cortez.

When Cortez was driven from the city of Tenochtitlan (Mexico City) in the battle of the "Noche Triste," with the loss of most of his army and much of his looted treasure, he took refuge from his pursuers in an ancient sacrificial temple consisting of a small pyramid surrounded by a stone wall. It was here that they dressed their wounds with "the boiling fat of an Indian," and vowed to build a church upon the site if they escaped death. They escaped by a near miracle and returned to build "Nuestra Señora de los Remedios."



ANCIENT AQUEDUCT OF LOS REMEDIOS

The water tower at one time was probably connected with a closed stone conduit, the ruins of which still extend from the base of the tower towards the church. The tower was undoubtedly intended as a stand pipe or tank to "float on the line." The pipe which can be seen extending from the top was cut from stone, and the masonry supporting wall surrounding it was designed; not as a fortress, but as a practical retaining wall. There is no indication of this structure's having been used as a defense works. A narrow spiral stairway, beautifully designed and constructed, leads to the top of the tower. A similar tower stands at the opposite end of the aqueduct and at a higher elevation (some 300 ft up the slope).

In Mexico there are many structures antedating the conquest, which are of engineering interest. Among them may be mentioned the "Great Stairway" at Monte Alban, in the state of Oaxaca—a terraced pyramid some 80 ft in height, which was probably formerly surmounted by a temple. Accompanying photographs show this structure and one of its drainage details.

HERBERT NUNN, Assoc. M. Am. Soc. C.E.
Secretary and General Manager,
San Dieguito Irrigation District

Encinitas, Calif.
August 1, 1937

THE "GREAT STAIRWAY"—PRE-COLUMBIAN ZAPOTEC ARCHITECTURE

THE DRAINAGE DETAIL OF THE GREAT STAIRWAY ILLUSTRATES THE SKILL OF THE ZAPOTECS IN PROTECTING THEIR RETAINING WALLS

Aspects of Flood Control

Dear Sir: I have read with a great deal of interest the article on "Economic Justification for Flood Protection" by Gilbert F. White in the May issue. The evaluation of flood damages as a basis for determining the amount to be spent for flood control, as used by the U. S. Army Engineers in preparing the 308 reports, has been found very unsatisfactory. The Corps of Engineers has been criticized for its findings when its reports have been limited by the authority under which they were prepared. Previous to the 1927 flood on the Mississippi, the Corps of Engineers was restricted to projects for maintaining navigation.

After this flood, congress recognized the control of the Mississippi as public work. A comprehensive plan was then prepared. Unfortunately the 100 per cent levee enthusiasts controlled the preparation of the plan.

In 1936 Congress passed a flood control act, which includes the control of the tributaries by reservoirs and levees. In 1933–1934 the Oklahoma legislature enacted a law authorizing the formation of conservancy districts. This act, which seems to have anticipated present conditions, outlines the following provisions:

The lands or other property within and without the basin to be acquired for rights of way, reservoirs, and other works should be appraised, as should all benefits and damages accruing to all lands within and without the basin by reason of the improvements.

The rights of land owners, municipalities, corporations, and other users of water to the waters of the basin for domestic use, water supply, industrial purposes, water power, or any other purpose, except irrigation, shall extend only to such use as could be made of such water if the improvements had not been made

Whenever the organization or improvements in the basin make possible a greater, better, or more convenient use of the waters of the basin for any purpose, the right of such waters shall be the property of the district and such rights may be leased, sold, or assigned by the district in return for reasonable compensation or use for irrigation purposes.

All parties desiring the waters, or water courses, of the basin may make application to the organization.

Where it is not possible or reasonable to grant all applications, preference shall be given to the greatest need and to the most reasonable use. Preference shall be given: (1) To domestic and municipal water supply, and no charge shall be made for the use of water taken by private persons for home and farm use, or for watering stock; (2) to supplying water used in processes of manufacturing; and (3) for irrigation, power development, recreation, fisheries, and other uses.

Assignments, leases, sales, or permissions may be for periods not greater than fourteen years. At the termination of the period of such assignments, leases, sales, or permissions, they may be renewed for a reasonable period not to exceed fourteen years, on the condition that a new determination is made of a reasonable charge therefor; unless there are other applications on file, the granting of which would result in filling a greater need or in a more reasonable use. In case such applications are on file they shall have preference.

Water rights for irrigation may be approved as is the rule in most western states. Riparian ownership to water rights is not recognized. This plan would tax all values accruing from the construction of improvements.

The activities and the work of the National Resources Committee are primarily responsible for the wider development of our water resources. The policy enacted into law by Congress in the Flood Control Act recognizes not only the necessity of flood control, but also the development of our water resources. The War Department through the Corps of Engineers, and the Department of Agriculture through several federal agencies are fully cooperating.

W. C. Burnham, Assoc. M. Am. Soc. C.E.
Engineer, Division of Water Resources
Oklahoma Planning and Resources Board

Oklahoma City, Okla
July 25, 1937

Dear Sir: In his paper on "Economic Justification for Flood Protection," in the May issue of Civil Engineering, Gilbert F. White has performed a valuable service in presenting to the profession the various aspects involved in the problem of evaluating the losses caused by floods and the benefits which may be credited to protective works. The correct principles of evaluation will probably be evolved through study, analysis, and discussion by those who are confronted with the problem. This assumption forms the excuse for this letter.

As Mr. White states, there can be no disagreement with the fundamental principle that the economic benefits should at least equal the costs. This principle should, of course, be applied to all engineering works. However, the same cannot be said of the question of what should or should not constitute benefits that may be credited to flood protection.

The evaluation of flood losses and benefits must be based on sound economic principles. Those principles are inherent in the economic structure of society and must be sought by means of thorough analysis and logical consideration of all pertinent factors. They cannot be set up by arbitrary dicta of any one organization, even if it be Congress.

Certain principles are reasonably clear and may be stated briefly as follows:

Losses should be limited to the reduction of community wealth by floods. The total losses of a community are not necessarily the sum of all individual losses but only the sum of those individual losses that are not gains to other individuals. Broadly speaking, valid losses include those sustained by physical property, losses of services and interruption of business, and costs arising from the emergency.

Speculative gains should not be allowed as benefits. This is simply a sound business principle. It will exclude as benefits the prospective development of detached areas. An apparent exception may be made in the case of urban areas adjacent to highly developed commerical sections; such areas have a value due solely to their location, and this value may be made available by flood protection works.

Economic losses and consequently benefits can be determined by two methods—namely, by estimating annual losses from observed flood damage, or by an appraised reduction of property values. These methods are mutually exclusive, and the two results cannot be added without inflating the benefits.

To obtain the annual losses as referred to above, an accurate census is required of all losses—direct and indirect or intangible—from which damage curves can be constructed. Frequency curves of the streams are prepared and drawn; these should be computed by the best methods available by utilizing the theory of mathematical probability and statistics. The product obtained by multiplying the stage-damage curve by the frequency curve, taken increment by increment, is the expected annual loss.

The reduction of property value is estimated through the differences in sale prices, tax assessments, and appraisals of property before and after the flood. This reduction is a capital loss. That it should not be added to annual losses—that is, through an assumed annual return on the capital loss or by capitalization of losses—is shown by the following considerations. Flood losses consist of damage to physical property, interruption of business, and emergency costs. Past floods are not responsible for the depreciation of property values in such a direct manner as they are for the foregoing losses. This reduction of value is a subjective loss which is brought about by the prospective purchasers or appraisers who express in capital terms the annual losses, reduced income, or lessened desirability, which are expected to result from future floods. The annual loss and reduction of value are therefore two different ways of expressing the same thing.

The foregoing principles do not cover all the phases of the evaluation of flood losses and benefits. Changing price levels should be considered in times of abnormal prices. In some cases, the question of the basic value of the monetary unit may require consideration. Where industry has not become stabilized, trends in population and industry should be examined. Virtually every flood-control project has its individual problem in evaluation of losses and benefits.

Edgar E. Foster
Associate Engineer, U. S. Engineer Office

Boston, Mass.
August 8, 1937

Herschel and the First Venturi Meter

To the Editor: Your June issue (page 419) describes a memorial tablet erected to Clemens Herschel as the designer of the Ferry Street draw span over the Quinnipiac River at New Haven. Anything about Mr. Herschel is, of course, of personal interest to those of us who have worked with him for so many years in connection with his historic invention, the Venturi meter.

It was J. J. R. Croes, Past-President Am. Soc. C.E., who in 1900 said that "the invention of the Venturi meter is sufficient to make the last quarter-century noteworthy in the annals of scientific progress." Another Past-President, C. F. Loweth, in 1923 also commented that the Venturi meter has done more "to conserve the water supply and eliminate waste than any other improvement of the century."

It occurs to me that it would be most fitting to place a tablet to Mr. Herschel at Belleville, N.J., where the first Venturi meter was installed and where Venturi tube No. 1 is still in place. I am inclined to think, also, that such a tablet should bear some reference to Messrs. Frederick N. Connet and Walter W. Jackson as the inventors of the first registering device for use with the Venturi tube.

Charles G. Richardson, M. Am. Soc. C.E.
Manager, Venturi Department,
Builders Iron Foundry

Providence, R.I.
August 6, 1937

Measuring the Discharge of Texas Streams

To the Editor: The paper by C. E. Ellsworth, Assoc. M. Am. Soc. C.E., in the July issue, calls attention to the fact that measurements, which have been made in Texas, show enormous rates of flood discharge on a number of the rivers and smaller streams.

The safety of river structures depends to a large extent on their capacity to pass the maximum discharge of the stream. Mr. Ellsworth points out that, according to flood flows in Texas, the maximum discharge of some of the streams is considerably greater than that found elsewhere. Engineers who are not familiar with Texas floods may underestimate the maximum flow of some of these streams, especially since the percentage of mean runoff to rainfall is smaller than in some parts of the country. The mean depth of runoff over a large area of the western part of the state varies from 2 to 8 per cent of the mean rainfall.

Since Texas floods are commonly caused by localized storm areas, a long runoff record does not necessarily mean that a flood of maximum flow has been measured; hence it may be desirable to determine from records of other nearby streams the maximum flood flow of the stream at the point in question. To accomplish this, some engineers plot the isohyetals, at short time intervals, of a severe storm on a nearby drainage area on which flow records are available, note the corresponding observed discharges at a given point, and convert runoff into percentage of rainfall. Then the isohyetals are traced and superimposed on the area in question, in the same position with reference to the north point; the area for each rainfall depth is measured with a planimeter, and after making allowances for variations in topography and so forth, the flow is estimated at the point in question. Considerable judgment is required to get an accurate estimate of the maximum flow by this method.

A good method to check the maximum flood flow is to plat all the known measurements on all streams in cubic feet per second per square mile of drainage area, then read the flow in cubic feet per second per square mile of the known area of the point in question. It appears that there are enough measurements in Texas to produce a fairly accurate estimate of the maximum flow in cubic feet per second on most of the streams, if it is borne in mind that some of the streams have steep slopes and others flat slopes, and that some of the drainage areas are fan-shaped, while others are long and narrow. Here again considerable judgment and experience are required to arrive at a reasonable estimate.

After maximum flow for design has been determined the duration can be estimated somewhat by using judgment in constructing a hydrograph similar in shape to some known measured flood on the stream at a point near the point in question.

The variation in discharge of many Texas streams is tremendous. With proper planning, and utilizing reservoir sites that are known to exist on several of the rivers, floods in Texas can no doubt be greatly reduced and much of the flood water put to beneficial use. Irrigation is needed for farming in a large part of the state; flood control is a paramount issue on most of the rivers; a good many cities depend upon surface water for their supplies; and considerable hydroelectric power can be generated in connection with many developments for other purposes.

J. L. Lochridge, Assoc. M. Am. Soc. C.E.

Austin, Tex.
July 23, 1937

Accurate Basic Surveys Needed in West Texas

To the Editor: The paper by Frank F. Friend, in the July issue, describing the resurvey of the University of Texas lands in West Texas is timely and interesting. This resurvey is perhaps the largest and most detailed ever made in Texas.

The situation he encountered is typical of all of West Texas. That vast area is a hodgepodge of railroad surveys, school surveys, county grant surveys, asylum surveys, and (along the Rio Grande) old Spanish and Mexican grants. These surveys were made during the time when the state was granting land for various purposes, and many of them were office, or "paper," surveys. The surveys made on the ground were made by diverse authorities, without any control or system. The surveys are irregular in shape—some run north and south, and others in any direction that apparently happened to strike the fancy of the surveyor. The land surveyed was worth little; the hardships and dangers were great, and the methods used were crude. Many conflicts and vacancies have developed. Some of these have been worked out and adjusted, but many still exist.

The valuable and extensive work done by Mr. Friend in his resurvey of the University lands, and by others in the resurvey of the Eighty-Mile Reservation and other resurveys, has done little more than establish a few points that can be tied to in that great expanse of West Texas, where the land is rapidly increasing in value by reason of growing population, the cutting up of the large ranches, and the development of oil and other resources. There is much work for surveyors and lawyers in that part of the state, and it is to be hoped that the example set by the University of Texas and by Mr. Friend in so thoroughly surveying and monumenting the lands owned by that institution will be followed by many other organizations so that confusion and costly litigation may be avoided.

It is evident that in so large an area as West Texas with such a confused system of surveys, there is great need of accurate basic control. Such control is available in the U. S. Coast and Geodetic Survey Primary Arc of Triangulation, which extends through that territory with well-marked and more or less accessible triangulation stations located from 20 to 50 miles apart. With regard to the accessibility of these triangulation stations, a suggestion is here parenthetically made to the U. S. Coast and Geodetic Survey that where stations are located on mountains, as is always the case when mountains are available, a pair of auxiliary stations be set on more accessible ground. This would involve only the measurement of a short base line and the reading of three angles. Climbing the mountain, finding the station, observing the angle, and erecting a signal for reading the other two angles is a difficult and expensive piece of work, which is not likely to be undertaken in an ordinary land survey. However, an auxiliary point, which could be reached without great difficulty, would be used.

There has never been any generally recognized or established system of surveys in the state of Texas, and the resulting confusion has been referred to in this discussion. I believe that, at this time, the state should adopt, and establish by law, a grid system based on geodetic control; and that ultimately all legal descriptions should be required to show the grid coordinates of the corners described in the field notes. Much extension of the control network will be required to make possible universal application of such a system, but a beginning should be made as soon as possible.

W. J. Powell, M. Am. Soc. C.E.
Consulting Engineer

Dallas, Tex.
July 26, 1937

Fall Meeting in Boston, Mass.

Held Jointly with the Engineering Institute of Canada
Hotel Statler to Be Headquarters, October 6–8, 1937
Program of Meetings, Entertainment, and Trips

Opening Session and General Meeting

WEDNESDAY—October 6, 1937—Morning

9:00 **Registration—Mezzanine Floor**

GENERAL MEETING

Imperial Ballroom

10:00 **Joint Meeting of the Society and the Engineering Institute of Canada called to order by**

FRANK A. BARBOUR, *M. Am. Soc. C.E., Chairman, Local Committee on Arrangements; Consulting Engineer*, Boston, Mass.

10:05 **Addresses of Welcome**

ALBERT HAERTLEIN, *M. Am. Soc. C.E., President, Northeastern Section; Associate Professor of Civil Engineering, Harvard Engineering School, Harvard University*, Cambridge, Mass.

His EXCELLENCY, CHARLES F. HURLEY, *Governor of the Commonwealth of Massachusetts*, Boston, Mass.

His HONOR, FREDERICK W. MANSFIELD, *Mayor of the City of Boston*, Mass.

10:30 **Responses**

LOUIS C. HILL, *President, American Society of Civil Engineers; Consulting Engineer*, Los Angeles, Calif.

GEORGE J. DESBARATS, *President, Engineering Institute of Canada.*

10:45 **Brief Addresses by**

JAMES BRYANT CONANT, *President, Harvard University*, Cambridge, Mass.

KARL TAYLOR COMPTON, *President, Massachusetts Institute of Technology*, Cambridge, Mass.

11:00 **Cultural and Technical Background of the "New Architecture"**

WALTER GROPIUS, *Professor of Architecture, Harvard University*, Cambridge, Mass.

WEDNESDAY—October 6, 1937—Noon

STUDENTS' LUNCHEON

12:00 to 2:00 Salle Moderne

COL. CHARLES R. GOW, *M. Am. Soc. C.E., Presiding*

Speaker: COL. WILLARD T. CHEVALIER, *Past-Director and M. Am. Soc. C.E., Vice-President in Charge, Civil Engineering and Mining Publications, McGraw-Hill Publishing Company, Inc.*, New York, N.Y.

All members of the Society will be welcome.

Tickets $1.50 each. Special price to members of Student Chapters, 50 cents each.

WEDNESDAY—October 6, 1937—Afternoon

GENERAL MEETING

Imperial Ballroom

Joint Meeting Conducted by the Engineering Institute of Canada

FRED NEWELL, *M.E.I.C., Member of Council; Assistant Chief Engineer, Dominion Bridge Company, Ltd., Presiding*

2:00 **Substructure of the New Highway Bridge Over the Fraser River at New Westminster, British Columbia**

MAJ. WILLIAM G. SWAN, *M.E.I.C., Consulting Engineer*, Vancouver, British Columbia, Canada.

Discussion opened by

R. E. CHADWICK, *M.E.I.C., President, The Foundation Company of Canada, Ltd.*, Montreal, Quebec, Canada.

F. P. SHEARWOOD, *Past-President, M.E.I.C., Chief Engineer, Dominion Bridge Company, Ltd.*, Montreal, Canada.

LEWIS E. MOORE, *M. Am. Soc. C.E., Consulting Engineer*, Boston, Mass.

3:00 **Recent Developments at the Port of Halifax, Nova Scotia**

EDWARD H. JAMES, *M.E.I.C., Consulting Engineer*, Montreal, Quebec, Canada.

Discussion opened by

J. B. STIRLING, *M.E.I.C., Engineer, E. G. M. Cape Company*, Montreal, Quebec, Canada.

R. E. CHADWICK, *M.E.I.C., President, The Foundation Company of Canada, Ltd.*, Montreal, Quebec, Canada.

RICHARD K. HALE, *Assoc. M. Am. Soc. C.E., Associate Commissioner, Department of Public Works*, Boston, Mass.

J. STUART CRANDALL, *M. Am. Soc. C.E., President and Chief Engineer, Crandall Dry Dock Engineers*, Cambridge, Mass.

4:00 **The Conception and Design of the Outardes Hydroelectric Project**

HENRY G. ACRES, *M. Am. Soc. C.E. and M.E.I.C., Consulting Engineer*, Niagara Falls, Ontario, Canada.

Discussion opened by

H. K. BARROWS, *M. Am. Soc. C.E., Professor of Hydraulic Engineering, Massachusetts Institute of Technology; Consulting Engineer*, Boston, Mass.

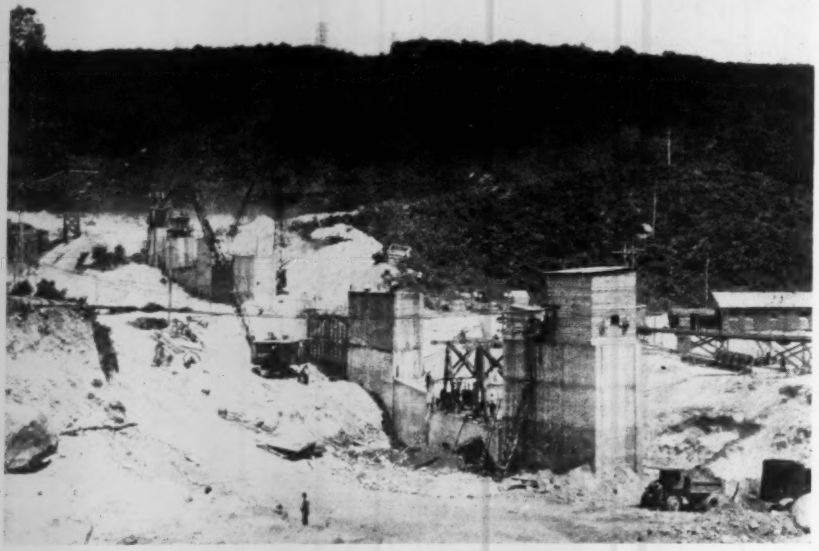
WEDNESDAY—October 6, 1937—Evening

ENTERTAINMENT FOR MEMBERS AND GUESTS INCLUDING LADIES

8:00 Imperial Ballroom

Buffet refreshments served at 10:30 p. m. Informal. Tickets are free to members, including members of Student Chapters. Each member may apply for one free ticket for a lady. Additional guest tickets may be purchased for $1.00 each.

Tickets should be obtained by 2:00 p.m. on Wednesday.



Caissons for Dike—Quabbin Reservoir

Caissons Being Sunk to Ledge Rock to Form Core Wall for Earth Dike at Quabbin Reservoir, Boston Metropolitan District Water Supply Project. Similar Construction Is Used with Caissons 125 Ft Deep for Main Hydraulic Dam Now Under Construction by Sluicing Method

THURSDAY—October 7, 1937

SOIL MECHANICS AND FOUNDATIONS DIVISION

Morning and Afternoon—Georgian Room

Carlton S. Proctor, *M. Am. Soc. C.E., Chairman, Soil Mechanics and Foundations Division, Am. Soc. C.E., Presiding*

10:00 **The Objects of the Division and Work Proposed**

Carlton S. Proctor, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

10:15 **Application of Soil Mechanics to Design of Levees in the Lower Mississippi Valley**

Spencer J. Buchanan, *Assoc. M. Am. Soc. C.E., Associate Engineer, U. S. Waterways Experiment Station, Mississippi River Commission,* Vicksburg, Miss.

Discussion opened by

Charles Senour, *Principal Engineer, Mississippi River Commission,* Vicksburg, Miss.

Theodore T. Knappen, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

11:15 **An Investigation of the Stability of Embankment Foundations**

Benjamin K. Hough, Jr., *Jun. Am. Soc. C.E., Associate Engineer, U. S. Engineer Office,* Ithaca, N.Y.

Discussion opened by

S. C. Hollister, *M. Am. Soc. C.E., Associate Dean, College of Engineering, and Director, School of Civil Engineering, Cornell University,* Ithaca, N.Y.

L. F. Harza, *M. Am. Soc. C.E., Consulting Engineer and President, Harza Engineering Company,* Chicago, Ill.

Recess for Luncheon

2:00 **Application of Soil Mechanics to Building Foundations**

Arthur Casagrande, *Assoc. M. Am. Soc. C.E., Assistant Professor of Soil Mechanics, Harvard University,* Cambridge, Mass.

Discussion opened by

Donald W. Taylor, *Assoc. M. Am. Soc. C.E., Research Associate, Soil Mechanics, Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology,* Cambridge, Mass.

Frank A. Marston, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

Thursday Devoted

SOIL MECHANICS AND FOUNDATIONS DIVISION—*Continued*

3:00 **Review of the Science of Soil Mechanics,** Outlining **Particularly Tests and Studies Now in General** Use in **Connection with Investigations of Soil Mechanics**

Glennon Gilboy, *Assoc. M. Am. Soc. C.E., Associate Professor of Soil Mechanics, Massachusetts Institute of Technology,* Cambridge, Mass.

Discussion opened by

Philip C. Rutledge, *Associate Professor of Civil Engineering, Purdue University,* Lafayette, Ind.

D. M. Burmister, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Columbia University,* New York, N.Y.

4:00 **General Technical Discussion—Methods** of **Boring** and **Sampling**

Presiding, William P. Kimball, *Assoc. M. Am. Soc. C.E., Assistant Professor, Civil Engineering, Thayer School of Civil Engineering,* Hanover, N.H.

Discussion opened by

Henry A. Mohr, *Assoc. M. Am. Soc. C.E.,* Waban, Mass.

SANITARY ENGINEERING DIVISION

Morning—Parlor A

Arthur D. Weston, *M. Am. Soc. C.E., Member, Executive Committee, Sanitary Engineering Division, Am. Soc. C.E., Presiding*

10:00 **Studies of the Pollution of Boston Harbor and Its Tributary Waters**

Arthur D. Weston, *M. Am. Soc. C.E., Chief Engineer and Director, Division of Sanitary Engineering, Massachusetts Department of Public Health, Boston, Mass.,* and Gail P. Edwards, *Laboratory Coordinator, Massachusetts Department of Public Health,* Boston, Mass.

Discussion opened by

E. Sherman Chase, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

Raymond R. Ribal, *Assoc. M. Am. Soc. C.E., Office Engineer,* City of Oakland, Calif.

Richard H. Gould, *M. Am. Soc. C.E., Engineer in Charge, Sewage Disposal and Intercepting Sewers, Department of Sanitation,* New York, N.Y.

11:00 **The Decomposition of River Deposits**

Gordon M. Fair, *M. Am. Soc. C.E., Professor of Sanitary Engineering, Harvard Graduate School of Engineering, Harvard University,* Cambridge, Mass.

Discussion opened by

Langdon Pearse, *M. Am. Soc. C.E., Sanitary Engineer, The Sanitary District of Chicago,* Chicago, Ill.

Harold W. Streeter, *M. Am. Soc. C.E., Senior Sanitary Engineer, U. S. Public Health Service,* Cincinnati, O.

Willem Rudolfs, *M. Am. Soc. C.E., Chief, Department of Sewage Research, State Agricultural Experiment Station; Professor and Head of Departments, Water Supplies and Sewage Disposal, Rutgers University,* New Brunswick, N.J.

chnical Division Sessions

SURVEYING AND MAPPING DIVISION

Morning—Parlor B

William Bowie, *M. Am. Soc. C.E., Chairman, Surveying and Mapping Division, Am. Soc. C.E., Presiding*

10:00 **Land Registration in Massachusetts**

Clarence B. Humphrey, *Engineer, Massachusetts Land Court,* Boston, Mass.

Discussion opened by

Raymond C. Allen, *M. Am. Soc. C.E., Civil Engineer,* Manchester, Mass.

11:00 **The Establishment of the Massachusetts System of Rectangular Coordinates**

E. C. Houdlette, *Engineer, Massachusetts Department of Public Works; Director, Massachusetts Geodetic Survey, Works Progress Administration,* Boston, Mass.

Discussion opened by

Herman J. Shea, *Jun. Am. Soc. C.E., Instructor, Civil Engineering Department, Massachusetts Institute of Technology,* Cambridge, Mass.

ENGINEERING-ECONOMICS AND FINANCE DIVISION

Morning and Afternoon—Parlor C

Edwin F. Wendt, *M. Am. Soc. C.E., Chairman, Engineering-Economics and Finance Division, Am. Soc. C. E., Presiding*

10:00 **Hazards of Uneconomic Public Works Construction**

Henry Earle Riggs, *M. Am. Soc. C.E., Honorary Professor, Civil Engineering, University of Michigan,* Ann Arbor, Mich.

Discussion opened by

William J. Wilgus, *Hon. M. Am. Soc. C.E., Consulting Engineer,* Ascutney, Vt.

Recess for Luncheon

2:00 **Engineering-Economics and Public Opinion**

Daniel W. Mead, *Past-President and Hon. M. Am. Soc. C.E., Professor Emeritus, Hydraulic and Sanitary Engineering, University of Wisconsin; Consulting Engineer,* Madison, Wis.

3:00 **Economic Advantages of Orderly Planning of Public Works**

Frederic H. Fay, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

Discussion

WATERWAYS DIVISION

Afternoon—Parlor B

W. G. Atwood, *M. Am. Soc. C.E., Chairman, Waterways Division, Am. Soc. C.E., Presiding*

2:00 **Recent Developments in Marine Borer Studies**

Dr. William F. Clapp, *Consulting Biologist,* Duxbury, Mass.

Discussion opened by

A. H. Morrill, *M. Am. Soc. C.E., Chief Engineer, Boston and Maine and Maine Central Railroads; Chairman, New England Committee on Marine Piling Investigation,* Boston, Mass.

Francis L. Sellew, *District Waterways Engineer, Massachusetts Department of Public Works,* Boston, Mass.

John N. Ferguson, *M. Am. Soc. C.E., District Waterways Engineer, Massachusetts Department of Public Works,* Boston, Mass.

3:00 **Repairs of Substructure, Army Supply Base, Boston**

Maj. Robert L. Miller, *U.S.A., Construction Quartermaster.*

Discussion opened by

George L. Mirick, *Senior Engineer, Construction Division, Quartermaster Corps, U.S.A.*

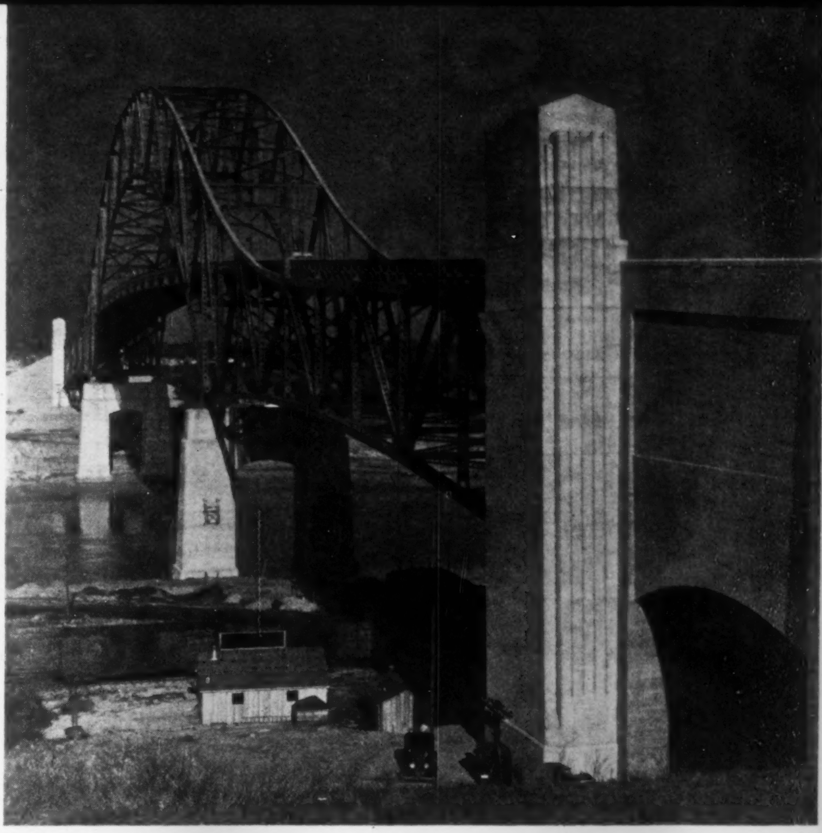
4:00 **Reconstruction of the Deck and Footings of Commonwealth Pier No. 5, at Boston, Mass.**

Charles M. Spofford, *M. Am. Soc. C.E., Hayward Professor of Civil Engineering, Massachusetts Institute of Technology; Consulting Engineer,* Boston, Mass.

Discussion opened by

John Ayer, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

C. J. O'Donnell, *Resident Engineer, Massachusetts Department of Public Works,* Boston, Mass.



Sagamore Bridge Over Cape Cod Canal

CITY PLANNING DIVISION

Afternoon—Parlor A

Harold M. Lewis, *M. Am. Soc. C.E., Chairman, City Planning Division, Am. Soc. C.E., Presiding*

2:00 **The Value of a Thoroughfare Plan and Its Relation to Metropolitan Systems Serving Urban Areas**

Frank H. Malley, *Assoc. M. Am. Soc. C.E., Acting Secretary, Boston City Planning Board,* Boston, Mass.

Discussion opened by

A. B. Edwards, *M. Am. Soc. C.E., Engineer, Massachusetts Division of Metropolitan Planning,* Boston, Mass.

The paper will be followed by a discussion on some phases of state planning of interest to civil engineers.

DINNER and DANCE—THURSDAY EVENING—See Following Page for Detailed Announcement

THURSDAY—October 7, 1937—Evening
7:00 DINNER AND DANCE—IMPERIAL BALLROOM

Presiding, PROF. EDWARD L. MORELAND, *M. Am. Soc. C.E., Head, Department of Electrical Engineering, Massachusetts Institute of Technology; Consulting Engineer,* Boston, Mass.

Speaker, PROF. ROBERT EMMONS ROGERS *of the Massachusetts Institute of Technology,* Cambridge, Mass.

Dancing until 1:00. Music by Marshard's Orchestra.

Tickets for dinner and dance, $3.00 each. Members of Student Chapters may obtain tickets for the dance only (9:30–1:00) for $1.00 per couple. Dinner dress.

Entertainment for the Ladies

Ladies Headquarters—The Library on the mezzanine floor will be reserved for the exclusive use of the ladies attending the Fall Meeting. Members of the Ladies Hospitality Committee will be present to aid the visitors.

WEDNESDAY—October 6, 1937

Morning

10:00 Ladies Will Be Welcome at the Opening Session in the Imperial Ballroom

Afternoon

2:00 Visit to Isabella Stewart Gardner Museum and Art Collection

This is of unique interest. During the visit there will be a talk by the Director and music. Tea will be served. The party will leave the Columbus Avenue entrance of the Hotel Statler at 2:00 p.m.; transportation will be by buses.

Tickets may be obtained at the Registration Desk without charge.

Evening

8:00 Entertainment—Imperial Ballroom

Ladies are invited to attend the entertainment for members and guests. Complete information will be found in the announcement elsewhere.

THURSDAY—October 7, 1937

Morning and Afternoon

10:00 Motor Drive to Lexington and Concord with Luncheon at the Wayside Inn, Old-Time Hostelry Made Famous by Longfellow and Restored and Now Owned by Henry Ford

Transportation will be by buses, leaving the Columbus Avenue entrance of the Hotel Statler at 10:00 a.m. Buses returning from Wayside Inn will arrive at the Hotel Statler about 5:00 p.m.

Free tickets for the trip and luncheon will be limited to one lady for each registered member of the Society and of the Engineering Institute of Canada. Additional tickets may be obtained at $2.00 each.

Tickets for this trip should be secured at the Registration Desk before 5:00 p.m. on Wednesday, October 6.

Evening

7:00 Dinner and Dance—Imperial Ballroom

PROF. ROBERT EMMONS ROGERS, *of the Massachusetts Institute of Technology,* will be the after-dinner speaker. There will be dancing until 1:00 a.m.

Complete information will be found in the announcement above.

FRIDAY—October 8, 1937

Morning and Afternoon

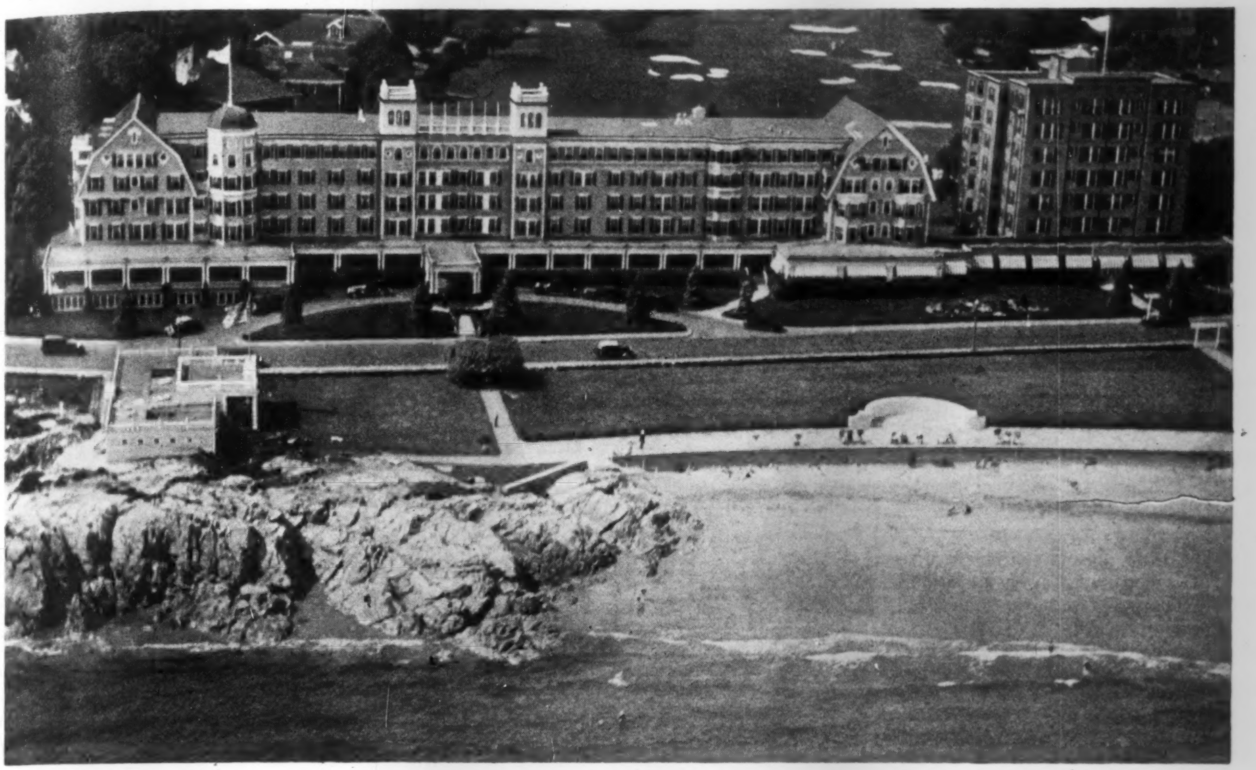
Ladies are invited to attend the trips which are to take place on Friday. Several different trips are planned, terminating at the New Ocean House at Swampscott for a "get-together" Shore Dinner.

Complete information as to these trips is given elsewhere in this program.

© *Boston Chamber of Commerce*

OLD STATE HOUSE, BOSTON
Declaration of Independence Was Proclaimed Here

CHRISTIAN SCIENCE PUBLISHING HOUSE
Contains a Mapparium, a Spherical Room 30 Ft in Diameter Showing the World in Color



NEW OCEAN HOUSE, SWAMPSCOTT, MASS.
The Friday Excursions Terminate Here for a "Get-Together" Shore Dinner

Excursions on Friday for Members and Guests

Several trips are planned for Friday morning, all ending with a "get-together" Shore Dinner at 1:30 p.m. at the New Ocean House at Swampscott where the afternoon will be devoted to recreation. In addition, several optional all-day trips to visit engineering projects at a considerable distance from Boston will be arranged if a sufficient number wish to attend.

FRIDAY—October 8, 1937—Morning and Afternoon

9:00 Buses leave the Columbus Avenue entrance of the Hotel Statler for Harvard University and the Massachusetts Institute of Technology. (Buses for the alternate North Shore trip leave at 10:30 from the same place.)

9:30 to 11:15 **Inspection at Harvard University**

Two trips are planned with competent guides, one for those wishing to inspect the engineering laboratories where methods of testing soils will be demonstrated in the Soil Mechanics Laboratory, and the other for those who wish to visit the Widener Library, the Glass Flowers, and other points of interest.

9:30 to 11:15 **Inspection at the Massachusetts Institute of Technology**

The following laboratories of particular interest to civil engineers will be open for inspection: Sanitary Engineering, Seismology, Cement Research, Building Materials Research, Soil Mechanics, and River Hydraulics (including an operating model of the Cape Cod Canal). Special arrangements can be made by those desiring to visit other features at M.I.T.

10:30 **North Shore Trip**

Buses leave the Columbus Avenue entrance of the Hotel Statler for a motor trip along the North Shore, visiting Revere Beach, Nahant and Marblehead, terminating at New Ocean House at 1:30 p.m. for the Shore Dinner. *This is an alternate trip planned for those who do not wish to visit Harvard or M.I.T.*

11:15 Bus leaves Harvard University (from gate at the Harvard Yard on Broadway opposite Memorial Hall) for M.I.T.

11:30 Demonstration of "High-Speed" Motion Pictures

By PROF. H. E. EDGERTON in Eastman Lecture Hall (Room 6-120), M.I.T.

12:30 Buses leave M.I.T. (from entrance directly outside Eastman Lecture Hall) for Swampscott, Mass.

1:30 "Get-Together" Shore Dinner at the New Ocean House, Swampscott.

2:30 to 4:30 Informal Dancing, Cards, Recreation, and "Loafing" at the New Ocean House Grounds

Recreational facilities include tennis courts, 1,000 yards of golf, and bathing pavilion.

4:30 Buses leave for the Hotel Statler. If a sufficient number desire to make an earlier return to Boston, arrangements will be made for one or more buses to leave the New Ocean House at 3:30 p.m.

Tickets for the Shore Dinner, including transportation, are $3.00 each. *These should be obtained at the Registration Desk not later than Thursday, October 7.*

Those desiring to take the North Shore Trip, instead of visiting Harvard and M.I.T. in the morning, should obtain a special bus ticket in order that proper accommodations may be provided. There is no additional charge for this trip. Any members desiring to drive their own cars to Swampscott can obtain tickets for the Shore Dinner only at $2.50, provided these are secured at the Registration Desk not later than Thursday, October 7.

Free tickets for transportation from the Hotel Statler to Harvard and M.I.T. and return to the Hotel Statler may be obtained at the Registration Desk for any members desiring to make these inspection trips who do not wish to attend the Shore Dinner.

MAIN COURT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Optional Trips on Friday, October 8, 1937

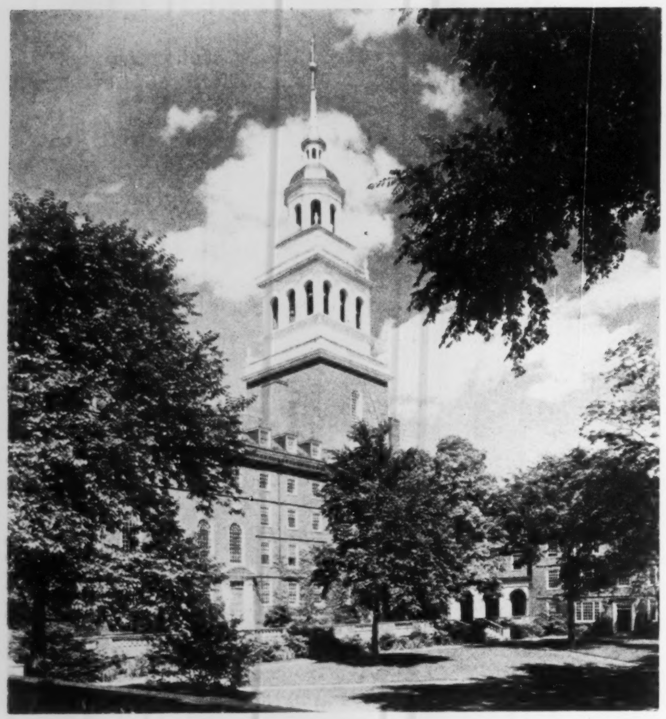
These will be arranged provided a sufficient number desire to attend. Transportation will be in private cars furnished by the committee, or in cars of members. Those interested in such trips should leave their names at the Registration Desk on Wednesday, October 6. Announcements as to whether these trips will be made will be available at noon on Thursday, October 7.

Trip to the Chelmsford Granite Quarries and to the Locks and Canals at Lowell, Mass., with Shore Dinner at Swampscott

This trip will provide an opportunity to visit the granite quarries of the H. E. Fletcher Company at West Chelmsford and the works of the Proprietors of Locks and Canals on the Merrimack River. At Chelmsford there will be an opportunity of viewing modern methods of quarrying granite using rotating core cutters, 4 ft in diameter, to release the pressure and place the material in a free state so that it can be split into sizes which can be handled by derricks. At Lowell may be seen the original drawings and models of apparatus designed by such early New England hydraulicians as James B. Francis and Uriah A. Boyden.

Transportation will be by private automobiles, leaving the Hotel Statler (Columbus Avenue entrance) at 9:00 a.m.

Tickets, including the Shore Dinner at Swampscott, $3.00.



Courtesy Harvard Film Service

LOWELL HOUSE, HARVARD COLLEGE

© New England Council

FAIRBANKS HOUSE, DEDHAM—BUILT IN 1636

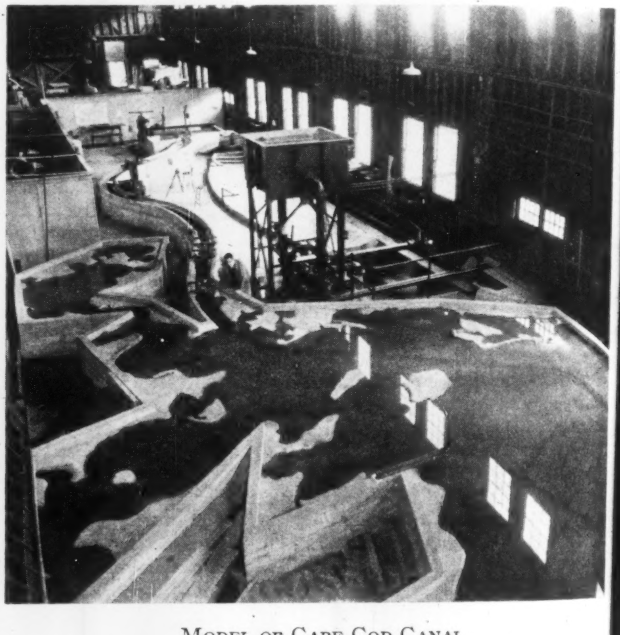
(This trip will be available only for those desiring to attend the Shore Dinner at Swampscott.)

Trip to Cape Cod Canal

This will be an all-day trip. Items of interest are the three new bridges over the Canal which have been completed recently, and the widening and straightening of the Canal, including dredging operations now under way.

Transportation will be by private automobiles leaving the Hotel Statler (Columbus Avenue entrance) at 9:00 a.m.

There will be no charge for transportation. Luncheon will be arranged at some point en route or at the Canal, members paying individually.



MODEL OF CAPE COD CANAL

Built in M.I.T. River Hydraulics Laboratory to Aid Army Engineers in Studying Tidal Flow in Connection with Improvements Now Under Construction at the Canal

Trip to Quabbin Reservoir, Boston Metropolitan District Water Supply Project

This will be an all-day trip. Points to be visited will include the completed control works for the diversion of the Ware River water and the earth fill dam, now under construction by hydraulic sluicing methods, at the Quabbin Reservoir on the Swift River.

Transportation will be by private automobiles leaving the Hotel Statler (Columbus Avenue entrance) at 9:00 a.m.

There will be no charge for transportation. Luncheon will be arranged at some point en route, members paying individually.

NOTE: These optional inspection trips will be arranged only if a sufficient number signify their desire to attend. Names should be left at the Registration Desk on Wednesday, October 6.

Hotel Accommodations and Announcements

In order to be certain of accommodations, members are urged to make definite arrangements for rooms at least a week in advance of the Fall Meeting, paying for the rooms in advance for at least a part of the period for which they expect to be in Boston.

Hotel Rates

Hotels	Single Room	Double Room
Statler Hotel	$3.50 up	$5.00 up
Bellevue Hotel*	3.00 up	4.00 up
Bradford Hotel	2.50 up	4.00 up
Copley Plaza	4.00 up	6.00 up
Parker House	3.00 up	4.50 up
Ritz Carlton	4.00 up	7.00 up
Touraine Hotel*	3.00 up	4.50 up
Westminster Hotel*	2.50 up	3.50 up

The rates quoted are the prices per day for a room with private bath. Hotels marked with an asterisk also have rooms without private bath at lower rates.

The Hotel Statler is the Meeting Headquarters, and it is expected that it will be able to care for all who attend. This hotel is located at Arlington Street and Columbus Avenue, near Park Square.

Reservations are to be made directly with the hotel as early as possible in order to prevent delay and inconvenience in obtaining accommodations on arrival. When making reservations, state kind of room desired, that is, single room inside; single room outside; double room inside, double bed; double room outside, double bed; double room inside, twin beds; double room outside, twin beds. Hotel will make acknowledgment of reservation direct to member.

All who attend the Fall Meeting are requested to register immediately upon arrival at Meeting Headquarters, mezzanine floor of Hotel Statler. Special badges and tickets will be obtained at the time of registration.

Information

A Registration Desk will be provided on the mezzanine floor of Hotel Statler to assist visiting members in securing any desired information about the city. At the Registration Desk, a card file of those in attendance will be maintained, with information as to members' hotel addresses in Boston. Printed lists of members and guests who register on Wednesday, October 6, will be available the following day.

Entertainment for the Ladies

Attention is directed to the entertainment provided for the ladies on Wednesday afternoon and on Thursday morning and afternoon. It is expected that they will participate with the members in any other features of the program in which they are interested.

The library on the mezzanine floor of the Hotel Statler will be reserved for the exclusive use of the ladies attending the Fall Meeting. Representatives of the Ladies Committee will be in attendance to be of service to the visitors.

Invitation to Student Chapters

Members of Student Chapters are invited to participate in all the events of the Fall Meeting. Particular attention is called to the Student Luncheon on Wednesday and to the dance following the dinner on Thursday.

Recreation and Side Trips

Those desiring to play golf or to take any trips not arranged on the program should apply at the Registration Desk, where they will be put in touch with a representative of the Committee on Entertainment and Service.

Order All Tickets in Advance

Members who order tickets in advance will not only be saved annoyance and delay by having tickets and badges awaiting them on arrival at headquarters (mezzanine floor of Hotel Statler) but they will assist the Local Committee greatly in giving advance information to guide it in completing arrangements.

See page 32 in the back of this issue for registration and ticket order forms.

Cooperating Committee of Engineering Institute of Canada on Arrangements for Joint Meeting

J. M. R. Fairbairn, *Past-President, M.E.I.C.*
F. P. Shearwood, *Past-President, M.E.I.C.*
E. A. Cleveland, *Past-President, M.E.I.C.*

Local Committees on Arrangements

Executive Committee

F. A. Barbour, *General Chairman*
F. H. Kingsbury, *Secretary*
A. W. Dean, *Director, Am. Soc. C.E.*
H. A. Gray, *Past-President, Northeastern Section*
W. R. Benford, *representing Providence Section*
J. P. Wadhams, *representing Connecticut Section*
F. A. Marston, *Chairman, Subcommittee on Technical Program*
F. M. Gunby, *Chairman, Subcommittee on Finance*
Albert Haertlein, *President, Northeastern Section; Chairman, Subcommittee on Hotel and Registration*
J. B. Babcock, *Chairman, Subcommittee on Entertainment and Service*

Subcommittees

Technical Program

F. A. Marston, *Chairman*

G. M. Fair
R. K. Hale
R. S. Holmgren
K. R. Kennison
R. S. Weston

Finance

F. M. Gunby, *Chairman*

H. K. Barrows
E. A. Dow
J. F. Fitzgerald
C. R. Gow
A. H. Morrill
C. M. Spofford
F. B. Walker

Hotel and Registration

Albert Haertlein, *Chairman*

C. W. Banks
A. D. Weston

Entertainment and Service

J. B. Babcock, *Chairman*

H. P. Eddy, Jr.
S. M. Ellsworth
F. S. Farquhar
H. A. Fidler
R. W. Horne
G. A. Montague
L. E. Moore
E. L. Moreland
K. C. Reynolds
B. F. Snow
F. E. Winsor

Student Participation

J. D. Mitsch, *Chairman*

F. N. Weaver
Albert Haertlein

Ladies Committee

Mrs. F. E. Winsor, *Chairman*

Mrs. F. A. Barbour
Mrs. A. W. Dean
Mrs. S. M. Ellsworth
Mrs. Albert Haertlein
Mrs. E. H. Rogers
Mrs. C. B. Breed
Mrs. H. P. Eddy
Mrs. F. M. Gunby
Mrs. R. K. Hale
Mrs. C. M. Spofford

The program as a whole has been prepared under the direction of the Committee on Regional Meetings, composed of Edward P. Lupfer, *Vice-President, Am. Soc. C.E., Chairman;* and C. Arthur Poole, Herman Stabler, C. E. Myers, Arthur W. Dean, and R. P. Davis, *Directors, Am. Soc. C.E.*

Please call on the Local Committee on Arrangements or on the Secretary's office for any service desired.

SOCIETY AFFAIRS

Official and Semi-Official

Detroit Welcomes Society Convention

Shares with Ann Arbor in Entertaining Successful Gathering, July 21–24, 1937

It is not often that visitors at Society meetings have the opportunity to enjoy two individual meetings, as was the case at the Summer Convention. First there was a large group that convened for several days at Ann Arbor. Upon transferring to Detroit, they were augmented by a much more numerous group for the Convention proper. Both parts of this double-header were delightful.

Circumstances at Ann Arbor were especially favorable. There, at the Michigan Union, is found a magnificent building that combines the best features of hotel and club under circumstances that only a fine progressive college community can offer. Committees of the Board began to gather as early as Saturday, July 17, and much real progress was made even before the Board itself got together on the Monday following.

But the series of events at Ann Arbor was not limited to Broad activities. Friends from Detroit, as well as local members, combined in holding a dinner for their guests on Monday evening, July 19. Then on Tuesday afternoon the attention of all was centered on the regular conference of Local Sections. This official activity, of Society-wide importance, drew representatives from the whole eastern part of the country. A broadened outlook resulted through the sharing of problems and the discussion of matters particularly affecting the general affairs of the Sections.

Transferred to Detroit

After the conference adjourned, towards the end of the afternoon, the delegates and Board members left by bus for the Statler Hotel in Detroit, headquarters for the Convention proper. There the following morning, Wednesday, July 21, the sixty-seventh Annual Convention was opened by George H. Fenkell, M. Am. Soc. C.E., chairman of the Local Committee, who presented Vice-President Edward P. Lupfer as presiding officer. The official welcome from the city and the state included a unique feature that was most appropriate—the hospitable words of Lieut. Gov. Leo J. Nowicki, Assoc. M. Am. Soc. C.E., who could speak from the dual standpoint of a state official and a member of the Society. Immediately there followed the annual address of President Louis C. Hill, delivered in his absence by Vice-President Lupfer.

The remainder of the morning session and all of the afternoon was devoted to consideration of a general topic, particularly appropriate to the local engineering and economic situation, that is, the subject of the trend of modern transportation. The single address in the morning on this subject, a delightful talk by Charles F. Kettering, president of the General Motors Research Corporation, dealt with the possibilities of future road transportation, particularly the part to be played by research. Concluding this session, as a part of the official Convention activities, a business meeting of the Society was called. Four amendments to the Constitution were before the meeting, and other items of general Society interest were also introduced, as noted more in detail elsewhere in this issue.

In the afternoon the symposium on transportation was continued, with Murray D. Van Wagoner, State Highway Commissioner, as the main speaker. Drawing on his extensive experience, he offered instructive comments on the topic of highway traffic and motor-vehicle taxation. A paper on the "Trend of Modern Highways" was also read in the absence of the author, Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads. Extensive discussion on these subjects occupied the rest of the afternoon.

Group Picture of Members and Guests Who Attended the Summer Convention of the Society at Detroit, Mich., July 21–24, 1937

Divisions Interest Themselves in Transportation

A departure from the general plan of Society Conventions was evident in the program for the following two days. Instead of one day of technical meetings and one day of inspection trips, the time was divided by devoting both mornings to the technical sessions and thus leaving the afternoons free for entertainment and sociability. Three Divisions scheduled discussions for Thursday morning, each with two papers. The Highway Division papers dealt with trunk lines and express highways. Very appropriately, the Waterways Division considered matters of transportation on the Great Lakes, with details on the engineering features involved in the St. Clair River. In the third meeting, the City Planning Division listened to two papers, both having to do with subsurface utilities, a subject in which the Division has long been officially interested.

Only one Division scheduled a session for Friday but this was a full one. The Sanitary Engineering group listened to three papers dealing with health features of highway traffic, such as tourist sanitation, roadside water supply, and public health activities.

Without going into the details of these Division meetings, it suffices to observe that all held most interesting sessions. The papers were thoroughly enjoyed and at their conclusion were frankly discussed. Members as well as visitors in attendance were amply repaid, both by the technical value of the subjects and the social contacts with engineers in the particular lines of work under discussion.

One other subject, also an important one, particularly from a local standpoint, deserves comment. A general session, balancing that of the Sanitary Engineering Division, was held on Friday morning. A single topic was presented, namely, the proposed Mackinac Straits Bridge, treated by Prof. James H. Cissel, long a student of the subject. After his presentation a most interesting discussion ensued from the floor. This is a most interesting subject to engineers in Michigan and many basic points of view were brought out.

When all these technical papers are subsequently presented in some detail to members, they can better judge of the enjoyment and value to those attending and participating. The entire general section of the October issue of Civil Engineering will be devoted to abstracts or reviews of these excellent treatments. Members will look forward to that elaboration on these subjects.

Nourishment for Body and Spirit Combined

More than usual, the Detroit Convention utilized the opportunity for combining luncheon and dinner meetings with more than a purely social outlook. A number of these events were on the program and in each instance some solid intellectual food was offered as well as the regular fare. The outstanding event of this nature was the dinner on Wednesday evening, July 21. Following a most

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Early Presidents of the Society—Thomas C. Keefer . . . p. 650

satisfying repast, the principal speaker of the evening was introduced in the person of W. B. Stout, engineer, aviator, artist, designer, and inventor. In addition, it should be added that Mr. Stout is a raconteur par excellence. His stories, mostly based on personal experience, were directly to the point. He traced some of the developments of transportation on the highways and railroads, and in the air, in all of which he has had a notable part. In particular he emphasized the influence of modern scientific design, not only in streamlining but in efficiency, whereby weight is reduced at the same time that strength is increased. This enjoyable address was followed by a popular dance in an adjoining ballroom.

Thursday noon, immediately following the morning sessions, another interesting occasion was in store, in the form of a luncheon meeting. The choice of a speaker was fortunate. It was Arthur E. Morgan, M. Am. Soc. C.E., who gave a serious address on the engineers' outlook towards economic and political matters, particularly as they affect the engineer in public life. Drawing on his long experience, he held the sympathetic interest of his audience. It is expected that the Society will have the privilege of printing a generous abstract of this paper at a later date.

In a similar way on the next day, a luncheon was arranged following the morning meeting. At its conclusion, opportunity was offered to present some features dealing with the recent development of engineering interest around Detroit. Through the generosity of a loyal citizen, part of his estate has become available for civic uses. This Rackham Fund has thus been used to advantage in a number of ways but in none of more interest to engineers than in the stimulation of the local engineering organization. Thus the Engineering Society of Detroit is entering a new period of prosperity and success, as told most interestingly by J. H. Hunt, vice-president of the General Motors Corporation.

Other Social Events Provided in Abundance

Both in Ann Arbor and in Detroit, the ladies in attendance were amply provided for. Luncheons, teas, bridge parties, and inspection trips were all on the program. At times the morning and afternoon events were separated; in other instances a more comprehensive event covered most of the day. In particular should be mentioned the luncheon and the afternoon spent so enjoyably at the Detroit Yacht Club; also the day devoted to inspecting the fascinating Greenfield Village, housing the historic collections of Henry Ford. The local ladies did everything in their power to make sure that their visitors spent every day advantageously and enjoyably.

For the afternoons of Thursday and Friday, general inspection trips were on the program. One of those on Thursday took in water supply and sewage treatment facilities for the city, together with an interesting ride; the other was primarily sight-seeing and included the Ambassador Bridge, as far as the International Line, Belle Isle with its wonderful park, and the Lake Shore Drive North of Detroit. Golf was also provided for those interested.

A single trip on Friday afternoon had as its objective the Detroit Zoological Park, with its miniature railway and its extensive exhibits of animals brought from all over the globe. A feature of this modern park is the extensive display of its animal life in the open, inclosed and protected by moats or water rather than bars. Also included in this trip was a visit to the famous church, the Shrine of the Little Flower, at Royal Oak, Mich. This unusual and beautiful structure excited widespread interest. The return trip traversed fine outlying sections of residential areas.

One of the most popular of the social events was arranged for Thursday evening. Advertised as a moonlight sail, it was really so in fact as well as in name. A glorious summer night, a large party of engineers and ladies, and the ample transportation provided, combined to make the evening an entire success. The route selected gave opportunity to view the Detroit waterfront, including the Ambassador Bridge, the city of Windsor, Ontario, the Detroit River and Belle Isle, and Lake St. Clair. As the conclusion of a summer day, this sail proved ideal.

Wayne County on Exhibition

One of the choice events of the Convention was reserved for Saturday morning. A general inspection trip was scheduled by automobile covering a field tour of Wayne County, which includes Detroit and surrounding territory. Here extensive developments have taken place to facilitate vehicular transportation. Super highways, parkways, grade separations, and elaborate roadside developments were on display. One particularly interesting feature of the inspection was a printed program with maps and illustrations, giving every detail to be included in the trip. The local engineers of the county road board have ample reason to be proud of their accomplishments and they provided a fascinating trip, excellently planned and carried out exactly to schedule. The entire trip of 80 miles was completed in time for lunch. It amply repaid those visitors who stayed over to enjoy it.

Many comments were heard as to the excellence of the arrangements for this meeting and the precision with which registration and other features were run off. The meeting accommodations were well centralized and conveniently arranged. In fact, all details reflected the excellent preparations and hard work of the local committee. Attendance totaled about 450. Warm were their praises and thanks for the excellent features provided by the Detroit and Ann Arbor members, all of which combined to make the Sixty-Seventh Annual Convention such a decided success.

Meeting of Board of Direction, July 19 and 20, 1937—Secretary's Abstract

On July 19 and 20, 1937, the Board of Direction met at the Michigan Union, Ann Arbor, Mich., with Vice-President Edward P. Lupfer in the chair, C. E. Beam, Assistant Secretary, acting as Secretary, and the following members of the Board: Messrs. Arneson, Bellinger, Burdick, Crawford, Davis, Dean, Dennis, Ferebee, Finch, Gowdy, Hidinger, Hill, Legaré, Leisen, Mead, Morse, Myers, Needles, Proctor, Shea, Stabler, Stanton, and Tuttle.

Approval of Minutes

Minutes of the meeting of the Board held on April 19–20, 1937, were approved; also minutes of the Executive Committee meeting held on July 18.

Federal Department of Public Works

The Board adopted a resolution looking towards the active participation by Engineering Council in efforts to create a federal de-

partment of public works; further, providing that the Construction League of the United States be advised with a view to cooperating with Council. This resolution is noted in detail elsewhere in this issue.

Appropriations

Additional appropriations were voted to the Engineering Societies Library and the American Standards Association; also an appropriation was made for a Student Chapter Conference to be held at Rapid City, S.D., in the fall of 1937.

Committee Reports

Reports were received from a number of committees, including those on Publications, Professional Conduct, and Honorary Membership.

Model Registration Law

The Committee on Registration of Engineers reported, presenting "A Revised Model Registration Law for Professional Engineers and Land Surveyors." The report of the committee was adopted, together with the Revised Model Law.

Future Society Meetings

The Board took action fixing the places for Society meetings for the ensuing two years, as follows:

1938 Spring Meeting—Jacksonville, Fla.
1938 Annual Convention—Salt Lake City, Utah
1938 Fall Meeting—Rochester, N.Y.
1939 Spring Meeting—Chattanooga, Tenn. (tentative)
1939 Annual Convention—San Francisco, Calif.

Committee Studies Authorized

The Board authorized appointment of a committee of its members to review and analyze the Society's functional activities and expenditures. The question of Division organization was referred to the Committee on Technical Procedure for study. The matter of the desirability of forming state sections of the Society was referred to the Committee on Local Sections and the Committee on Districts and Zones.

Professional Conduct

Several matters before the Committee on Professional Conduct were presented to the Board for information and appropriate action.

Professional Development

Report was received from the Engineers' Council for Professional Development and referred to the appropriate committees.

Local Sections Amend Constitutions

Approval was given to requests of the Colorado, Indiana, Cleveland, and Connecticut Sections to amend their constitutions.

New Local Sections

Upon petition by members of the Society duly presented, two new Local Sections of the Society were authorized, as follows: Mid-Missouri Section and West Virginia Section. A separate item in this issue gives the details.

Federal Work Relief Activities

A resolution was adopted, as noted elsewhere in detail, urging curtailment in current federal work relief activities.

Minutes to Commemorate Deceased Members

The Board paid tribute to the memory of Harrison P. Eddy, Past-President, Am. Soc. C.E., and Ambrose Swasey, Hon. M. Am. Soc. C.E. Its high regard for these eminent engineers was expressed in minutes formally adopted as follows:

Harrison P. Eddy

"Mr. Eddy devoted his life to the advancement of the engineering profession. He became a member of the American Society of Civil Engineers in 1902, and after serving with distinction as a member of the Board of Direction from 1928 to 1930, he was honored by election to its highest office as President in 1934, subsequent to which date his activity was continued through the years 1935 and 1936 as a member of the Board.

"In the death of Mr. Eddy the Board of Direction recognizes that the profession has sustained an irreparable loss of a sagacious leader, that American municipalities have been deprived of the services of one of the outstanding sanitary engineers, and that members of the Society have lost a beloved friend.

"The Board hereby records its sincere grief and extends its deepest sympathy to Mr. Eddy's family in their bereavement, and directs that a copy of this minute be spread upon its records and transmitted to his relatives."

Ambrose Swasey

"Whereas death has called our fellow Member, Ambrose Swasey, who departed this life on June 15, 1937,

"And Whereas Dr. Swasey was a man respected and endeared to all who knew him, through his gracious and genial personality; his abilities as a scientist, engineer, and administrator; great benefactions to engineers and others; and his qualities as a Christian gentleman;

"Be it resolved that the Directors of the American Society of Civil Engineers in meeting assembled hereby express their deep regret at the passing of our friend and fellow member and that we desire to express to the members of his family, our sympathy in their great loss."

Adjournment

The Board adjourned to meet in Boston, Mass., on October 4, 1937, in connection with the Fall Meeting of the Society.

Minutes of Society Meeting, July 21, 1937

Abstract of Session at Detroit Convention

A BUSINESS SESSION of the Society was called in connection with the Annual Convention in the Hotel Statler, Detroit, Mich., on Wednesday morning, July 21, 1937, with Vice-President Harry W. Dennis in the chair. The special order of business was announced as the presentation for discussion of four amendments to the Constitution.

Proposal No. 1 provides for the increase in the number of Honorary Members elected annually. It was voted that this proposal be sent to letter ballot, accompanied by statements pro and con, written by committees appointed for that purpose by the President of the Society.

Proposal No. 2 provided for a new grade of Student Member. This proposal was amended, on advice of counsel, to simplify the wording (by the omission of a restatement). The meeting also instructed the President to select committees for preparing statements in favor of and against the proposal. It was voted that Proposal No. 2 as amended be sent to letter ballot accompanied by the two statements.

Proposal No. 3, dealing with the change of "Junior" to "Junior Member," was also presented. Similar action was taken to that in the case of Proposal No. 2; that is, with clarifying amendment, plus statements of committees for and against the proposal, it was to be sent out to letter ballot.

Proposal No. 4 had to do with the nomination of Society officers, and provided that members not residing in North America should be omitted from voting on such nominating ballots. A simplifying amendment was proposed but not voted upon. After considerable discussion, it was voted that Proposal No. 4 be referred to a committee appointed by the President and instructed to report at the January meeting of the Society.

On motion, the meeting formally requested the acting president to appoint a Society committee to study the question of unionization of engineers. By action of the meeting, the Secretary was instructed to cable regards and best wishes to President Louis C. Hill and Secretary George T. Seabury, both absent on account of ill health.

FALL MEETING of the Society, October 6–8, 1937, at Boston, Mass.

Ann Arbor Host to Local Sections Conference

Following immediately after the closing session of the Board of Direction at Ann Arbor, representatives of the 30 Local Sections in the Northern Meeting Region gathered together at the University of Michigan Union on Tuesday afternoon, July 20, 1937, for their Annual Conference. Holding the conference at this time and place gave members of the Board the opportunity to be present. The conference was presided over by E. B. Black, of Kansas City, a member of the Society's Committee on Local Sections.

Special Subjects on Program

The program of topics discussed included a résumé of the history and present status of the move to allocate every member of the Society to some one or another Local Section and to increase the assignment of Society funds to Sections for carrying on their work. This résumé was given by Director H. S. Morse, chairman of a special committee appointed by the Board to study and harmonize the various modifications of the plan proposed by the Society's Committee on Local Sections. A summary will be found elsewhere in this issue.

Considerable time was devoted to the current movements to unionize the engineering profession. Van Tuyl Boughton, former president of the Metropolitan Section of the Society, led the discussion by delivering a thoughtfully prepared talk. This also is reprinted on another page. Mr. Boughton's address was followed by much active discussion concerning steps that should be taken on behalf of the younger members of the profession who most need encouragement and help from the Society and its Local Sections.

The conference took unanimous action requesting the Board to appoint a committee to study the problem of the engineer and his relation to the union movement. As a result of further action at the meeting of the Society in Detroit on the following day, the President of the Society has appointed a committee to study this problem for report at the time of the October meeting.

Joint Meetings

The discussion of the subject, "How to Mix Activities of Corporate Members, Juniors, and Members of Student Chapters," was led by Earl F. O'Brien, president of the Syracuse Section. There for ten years the Section has held a social meeting each year jointly with the Student Chapter of Syracuse University. It is also sponsoring a regional meeting of all Sections and Chapters in New York State, planned for the spring of 1938, thus attempting to bridge the gap between students and Corporate Members. Such a conference has the further advantage, Mr. O'Brien believes, in handling to advantage problems of state-wide interest, such as the recent proposal of the New York legislature to put all positions under Civil Service.

Continuing on the general topic, F. W. Epps, secretary of the Kansas State Section, mentioned the success his Section had recently in bringing the student members from the Chapters at the University of Kansas and Kansas State College to a joint meeting at which the Section presented to two students the Section prize of a membership in the Society in the Junior grade, together with a certificate from the Section.

E. O. Brown, vice-president of the Dayton Section, reported a successful joint meeting in which the Section held its annual meeting at the University of Dayton as guests of the Student Chapter. Four members of the Chapter, each a foreign student, presented an interesting program regarding conditions in their respective countries. There was a tour of the laboratories, ending with a student luncheon and smoker.

Sections at Cincinnati, St. Louis, Chicago, Boston, and New York not only reported well-attended joint meetings but the Metropolitan Section has been very successful with their Student Chapter conferences. The Indiana Section, for several years, has sponsored a two-day annual inspection trip to the steel-manufacturing district around Gary. The caravan goes by auto, with only one member in a car, the rest being students. Members of the Indiana Section recently accepted invitations to spend a night in the Purdue University civil engineering camp with the students. During the Meeting of the Society in Boston this fall, the Northeastern Section has planned a student luncheon at which the students will be the guests of the Board of Direction of the Society and the Section.

Junior Forums

Milo S. Ketchum, Jr., Jun. Am. Soc. C.E., representing the Illinois Section pointed out the close relation between the union movement and Student Chapter problems. He felt that when the graduate leaves school he still has four or five years of "apprenticeship" before him before he may enter the profession. It is during this period, he said, that steps must be taken to give him a professional viewpoint.

Mr. Ketchum was instrumental in the start of the Junior Association of the Colorado Section and more recently has been active in getting a Junior Forum of the Illinois Section under way. Successful meetings are being held but it has been found that the nature of the Juniors' employment often makes it impossible for them to attend with any degree of regularity. In this Mr. Ketchum felt that employers of Juniors should encourage attendance by allowing time off for meetings of Juniors, of Sections, and of the Society. When Juniors can be found who have the available time, they make energetic aids to Section officers.

Admiral R. E. Bakenhus, vice-president of the Metropolitan Section, gave a résumé of the very successful program of the Junior Forum in New York in conducting a course in effective public speaking under an instructor. The course closed with the finals of a competition before the Metropolitan Section and the award of the Section's prize. Attendance at Junion Forum meetings ranges from 50 to 120. Organization of a Junior Forum is being actively considered by the Kansas City Section.

Build Diversified Programs

Speaking on the subject of papers presented and the method in which they are presented, William H. Chorlton, president of the Philadelphia Section, addressed the Conference on the subject of "Programs That Will Be Attractive to Corporate Members, Juniors, and Students Alike." He pointed out the experience of the Philadelphia Section that programs which attract Corporate Members are likely to interest also the Juniors and members of Student Chapters, but attention must be given to diversifying the program.

During the past three years, the Philadelphia Section has conducted Student Chapter conferences at which three papers have been selected for the Section's cash prizes. However, the Juniors of this Section, who conduct regular monthly forum meetings, find that there are two subjects of particular interest to them—that is, structures, both theory and practice; and the political and social sciences.

Juniors and students want papers at Section meetings to go thoroughly into the theory and to be well illustrated with good drawings, diagrams, or lantern views. They want to know something of the civil engineer in his relation to society. Older members should not let the younger members isolate themselves in a corner. The latter appreciate the feeling that they are heartily welcomed by the older members. The speaker who is selected must not only know his subject but he must also be able to present it in an interesting manner.

The Kansas City Section has successfully built up attendance at its meetings by injecting a reasonable amount of fun and entertainment into the programs. W. M. Spann, M. Am. Soc. C.E., reported an attendance of 90 out of a total membership of 106 at its last meeting.

Local Publicity for Engineers

Speaking on the final subject on the agenda for the conference, "Local Publicity for Engineers," J. H. Porter, president of the St. Louis Section, stated that civil engineering already has a great deal of publicity. Rotogravure sections are filled with excellent pictures of bridges, dams, and other engineering projects. "Newspapers are seeking news all the time," he said. Engineers must drop a great deal of their technical language and adopt for the press a language the laymen can understand. Engineers are enthusiastic about their work but are too often afraid or too modest to let their enthusiasm show. They should show that they realize the importance of their work.

The conference adjourned just in time for the representatives to pack up and catch busses for Detroit, where the Annual Convention of the Society began its sessions the following day.

Early Presidents of the Society

Among the members of the Society there are doubtless many who came into intimate contact with Thomas Coltrin Keefer in the latter years of his life. Such persons are requested to review this article carefully and submit any additional information that it is believed will be of interest to the Society's members. Information on Max Joseph Becker, William Powell Shinn, and Octave Chanute, whose stories will appear in forthcoming issues, also will be appreciated.

XVIII. THOMAS COLTRIN KEEFER, 1821–1915

President of the Society, 1888

WHEN the Society went to Ottawa for its Convention, in June 1913, Thomas Coltrin Keefer, "grand old man of Canadian engineering," gave a garden party for all the visiting members. He was almost ninety-two years old, and he had to sit in his arm chair to receive his guests; but probably no one more thoroughly enjoyed the occasion than did he. It was a characteristic gesture, that party which brought together outstanding men from Canada and from the United States. And it was a symbolic one, for much of his life had been spent in promoting international intercourse and good will.

THOMAS COLTRIN KEEFER
Eighteenth President of the Society

Keefer might well have inherited a quite different attitude toward the United States. During the Revolution his grandfather, an Alsatian Huguenot living in New Jersey, had lost his property and his life in defense of the Crown. In 1790 his father, left penniless by the confiscation of the family fortune, had gone to Canada to take a homestead offered him as a Loyalist by the Canadian Government. And in 1812 and 1813, close by that homestead, Yankee forces had engaged the Canadians in battle.

Nevertheless, Keefer's inheritance was one of friendship rather than of antagonism to the United States. Within a decade of the close of the war his father, George, became one of the incorporators, and the first president, of the Welland Canal Company, an organization that drew heavily on United States capital. Within five more years the canal was completed. And one of Thomas Keefer's boyhood memories was of that day in November 1829, when the first two vessels—one British and one American—passed his home, together, on their way up the canal from Lake Ontario to the Welland River and Lake Erie.

Keefer was born at Thorold, Ontario, near Niagara Falls, on November 4, 1821. He was graduated from Upper Canada College in 1838, and commenced his training for the profession of civil engineering on the Erie Canal, in New York State. He shortly became a division engineer on the Welland Canal, remaining there until 1845.

During this period the Welland Canal was being enlarged and improved. Its summit level was being lowered, so that Lake Erie could become the feeder, and the 40 wooden locks, 110 ft by 22 ft in plan, were being replaced by 27 stone locks, 150 ft by $26^1/_2$ ft in plan.

In 1845 he became chief engineer of the Ottawa River improvement works, which were designed to facilitate the lumber traffic in the western part of the province of Quebec. This project he completed three years later, though he continued to be associated with it as consultant for almost 50 years.

By the end of 1848 the United States had 8,092 miles of railroad; Canada had but 38. In the hope of stimulating construction north of the border, Keefer the following year wrote a lengthy essay entitled "The Philosophy of Railroads." His thesis was that since the sparse population of that country would scarcely permit the building of railroads as a commercial venture, it was the duty of the government and the municipalities to aid this construction in every possible way. He painted a vivid word picture of the effect railroads would have on the development of the country; he showed how the indirect profits arising from this development would repay the government for its assistance many times over; and he warned that if railroads were not built there might well develop a wholesale emigration to the United States.

This essay had a wide circulation and, according to two early biographers of Keefer, it "greatly influenced the governmental policy regarding the construction of railways," and "earned for its author the right to be considered as the father of railways in Canada." By 1855, the railroad mileage had increased to 1,218; and in 1878 Canada stood eighth of all the countries of the world in absolute mileage (5,700 miles) and fifth in miles per inhabitant.

The same year that the "Philosophy of Railroads" appeared, Lord Elgin, Governor General of British North America, offered a prize for the best treatise on the bearing of the St. Lawrence and Welland canals on the interests of Canada as an agricultural country. Keefer won, over nine other contestants. Probably as a result of this award, he was chosen by the government in 1850 to survey the rapids of the St. Lawrence (above Montreal) "with a view to the improvement of its navigation by the exploration of easier and safer routes." He was also to investigate the possibility of constructing a canal or railroad that would link the lower St. Lawrence with the upper St. John (north of the northern tip of Maine) and, via the latter river, through the province of New Brunswick, with the Bay of Fundy.

Just how many years Keefer spent altogether on various St. Lawrence waterway projects it would be difficult to say, but more than a half century after these first investigations he was still engaged in the work—ultimately as a member for Canada of the International Deep Waterways Commission, enquiring into the practicability of a ship canal between the Great Lakes and the Atlantic.

Keefer's first contribution to international relationships was made when he was still less than 30 years old, his government having appointed him to act with I. D. Andrews, the United States consul, in preparing the reports on Canadian trade that led to the Reciprocity Treaty of 1854. It is said that his knowledge and grasp of the commercial situation were very instrumental in the drafting of the treaty itself.

About the same time he was further honored by Lord Elgin with appointment as one of the Canadian Commissioners to the London International Exhibition of 1851. This type of work, with the opportunities it provided for encouraging international trade, seems to have appealed strongly to him. He was Canadian commissioner again at the London Exhibition of 1862, and finally, chief executive commissioner to the Paris Exhibition in 1878, where he served as a member on the international jury on architecture and engineering. (For his work at Paris, Queen Victoria made him a Companion of the Order of St. Michael and St. George, and the French government made him an Officer of the Legion of Honor.)

One of the earliest Canadian railroads was the Kingston and Toronto, chartered in 1851. (It was shortly absorbed by the Grand Trunk Railway Company of Canada, which in turn merged into the Canadian National Railway Company in 1923.) As its chief engineer, Keefer made the preliminary surveys for the line between Montreal and Toronto. He also prepared plans for bridging the St. Lawrence at Montreal to provide railroad communication with the United States—and it was from these designs that the Victoria Bridge was built, despite the fact that "the weight of professional opinion" favored an entirely different plan. Other engineers had advocated a drawbridge across the wider portion of the river, above the city; but Keefer selected the narrower location at Point St. Charles, and did away with the draw span by designing his approaches with ascending gradients.

In the following years he engaged in such a wide variety of enterprises that only a brief mention of part of them can be made here. He served for a while (beginning in 1853) as engineer to the

Montreal Harbor Commissioners. He constructed the water works for Montreal, Hamilton, and Ottawa, and was consulting engineer on water works at Quebec, Toronto, and a number of other cities. He was chief engineer of various railroads. The Toronto *Globe* commented that "his engineering works have made his name familiar throughout Canada, and his writings have stamped him as a man of remarkable foresight in public affairs."

Especial mention should be made of his earnest advocacy, in 1869 and 1870, of the building of the Canadian Pacific Railway. The "Philosophy of Railroads," fortified by twenty additional years of experience, and remolded to fit the case, was again set to work shaping public opinion. This time it appeared as a series of letters, pointing out that the construction of the Canadian Pacific had been made necessary by the extinguishment of the claims of the Hudson Bay Company to the great Northwest territory, and that it was essential to Canadian confederation and internal development.

It may be noted that when British Columbia became a part of the Dominion, in 1871, the principal condition of union was that this road should be completed to the Pacific seaboard within ten years. Financial and political difficulties prevented that schedule from being met, but the work was pressed as rapidly as possible and was actually finished in 1885.

Near the end of the job, Keefer was called on to serve as arbitrator in disputes that had arisen between the Canadian Pacific Railway Company and the Dominion government, which had built part of the line.

In 1877 Keefer became a member of the Society. He took an active interest in its affairs, becoming a vice-president in 1886. The following year he helped to found, and became the first president of, the Canadian Society of Civil Engineers (which in 1918 became the Engineering Institute of Canada). Ten years later he served a second term as president of that society—the only man ever thus honored. In 1888 he was made president of the American Society. Honorary membership was conferred on him by the Institution of Civil Engineers (Great Britain) in 1912, "because of the distinguished part he has taken in the engineering enterprises which have aided so largely the development and prosperity of the Dominion of Canada. . . ."

Keefer died at Ottawa on January 7, 1915, in his ninety-fourth year.

His eldest son, Charles H. Keefer, was at that time a Director of the Society, with a consulting engineering practice in Ottawa; and in partnership with Charles was the latter's son, Thomas C. Keefer, Jr. Thus the Keefer family can lay claim to the perhaps unparalleled record of having produced four consecutive generations of engineers.

[Much of the foregoing information has been taken from a sketch published in *Engineering News* for January 1, 1888. The assistance of T. K. Thomson, M. Am. Soc. C.E., in supplying additional details and in reviewing the present article is gratefully acknowledged.]

Local Sections to Embrace Entire Society Membership

Interesting developments are taking place in the plan providing that each member of the Society shall be allocated to some appropriate Local Section. A brief review of the history and status of this idea may be of help to members in understanding the movement. It was proposed by the Committee on Local Sections and first presented to the Board of Direction at its meeting in July 1936. Since that time it has been the subject most discussed at succeeding Local Sections Conferences—at Portland, Pittsburgh, San Antonio; and Ann Arbor.

In 1919 the Society's Committee on Development made as one of its recommendations "that every member be assigned to a Local Section." This report was submitted by the Board of Direction in the form of a questionnaire ballot to the Corporate Membership for its opinion. The result on the specific question, "Shall Local Sections be created to embrace the entire membership?" was $3^1/_2$ to 1 in favor of it. Since 1919, the 22 local associations of members has grown to become 61 Local Sections, in which nearly 5,500 members of the Society show their interest to the extent of paying local dues.

In his annual address at Los Angeles in July 1935, President Tuttle recommended and urged that further steps be taken to include the entire membership in the work of the Local Sections. The Committee on Local Sections, in its 1936 report to the Board, stated "that one of the important activities of the Society is the work done or that may be done by its Local Sections. If a Section's activities are favorably considered and meet with approval, members will be attracted to it and to the Society and public consciousness of the profession will be built up." At its meeting in January 1937, the Board adopted the policy of encouraging the formation of new logically located Local Sections, and it has undertaken steps to further increase the number of Sections. Four new Sections have been formed during 1937.

Under existing conditions, each Local Section obtains financial support for carrying on its work from two sources—a part from the collection of local dues from its members, and a part from an allotment made by the Society. The amount of the allotment has been determined by the matching of the local dues collected. In 1937, the Society returned $11,300 to Sections by matching 1936 dues.

The inconsistency of this method of support has been that only the 5,500 who support the work of Sections have received the benefits of the Society's financial cooperation. The remaining members have contributed towards the cooperation without directly benefitting therefrom.

So that every member of the Society may enjoy the full benefit of his membership, it has been stated as a principle by the committees studying these plans that by reason of his membership every member is entitled to belong to some Local Section and to enjoy all the privileges and activities of that Section except the right to vote and hold office. It is proposed, however, that only the members who also subscribe to the constitution and by-laws of the Section, may vote, hold office, and otherwise participate in the government of that Section. If the Section elects to collect local dues, the members who subscribe to the constitution will also pay the prescribed dues. In this way the collection of dues by a Section would be left as a matter for the Section itself to decide.

The proposed plan recognizes that some members of the Society may be uninterested in Section activity, and the plan does not contemplate any pressure on such members to force their interest. Such members, however, will habitually receive all the communications and publications of the Section so that they may, if they choose, take advantage of the opportunity offered by the Section to attend and paticipate.

Local Sections have not all determined the extent of their areas. So that members may be definitely allocated, it is proposed that the Sections delineate their boundaries by mutual agreement between adjacent Sections, the final boundaries to be approved by the Board of Direction. In determining boundaries of existing Sections, they will study the possible advantages that may result from the combination of some smaller existing Sections; the desirability of subsections within the areas of larger Sections; and the added strength that may come from joint efforts of all the sections in a State or other natural area.

The proposed assignment of funds to Sections is to include a per capita amount based on the number of members in the Section plus an amount based on the needs and activities of the Section, such as the amount of local dues collected and the number of meetings held.

According to the plan proposed, the number of members of the Society who will come under the influence of a Section will be expanded from 5,500 to 13,800.

At its Ann Arbor meeting, the Board received notice of an amendment to the By-Laws of the Society designed to initiate the plan at the beginning of the year 1938, and to carry it out. The amendment will be acted upon at the fall meeting of the Board, when the Board also will consider the report of its special committee.

Reinstatement in Society Not Costly

An erroneous impression seems to exist among former members of the Society that reinstatement is extremely difficult and expensive, and that it involves the payment of dues for the entire period since the connection with the Society ceased.

Realizing that many members are now desirous of renewing their connection with the Society, the Board of Direction has adopted rules designed to make reentry as easy as possible, dependent on length of previous membership and so forth.

Members are requested to bring this information to the attention of former members, suggesting that correspondence with the Secretary will readily establish the exact situation in each case.

New Local Sections Authorized

OFFICIAL STEPS were taken by the Board of Direction at its Ann Arbor meeting looking towards the addition of two new Local Sections in the Society. In the case of the Mid-Missouri Section, a group of members centering around Jefferson City submitted a petition in proper form, together with the proposed constitution and by-laws. The Board approved of this action and provided the necessary appropriation for instituting the Section.

In the case of the West Virginia Section, with headquarters at Charleston, a petition only was received. This the Board also approved, leaving until a later date the necessary action on the constitution when it is submitted. The West Virginia Section is thus assured of the necessary Board action on completion of the required details.

Action on these two cases indicates a further growth in sentiment towards expansion of Society work in individual communities. Previously, the newest Section was that in Kentucky, approved by the Board in January 1936. Formation of still another Section, in and around Lansing, Mich., is also in progress and has received Board sanction. When all these new groups are officially added, the total number of Local Sections will be 61. In the 1937 Year Book it is listed as 59.

Results of First Ballot for Official Nominees

New York, N.Y.
August 2, 1937

To the Secretary
American Society of Civil Engineers:

The tellers appointed to canvass the First Ballot for Official Nominees report as follows:

Total number of ballots received		1,627
Deduct:		
Ballots from members in arrears of dues	106	
Ballots without signature	4	
Ballots with illegible signature	1	
Ballots from members who have died since voting	2	
Total withheld from canvass		113
Ballots canvassed		1,514

For Vice-President, Zone I

Malcolm Pirnie	236
Scattering	138
Void	26
Blank	76
Total	476

For Vice-President, Zone IV

E. N. Noyes	162
J. C. Stevens	69
J. H. Brillhart	46
Raymond A. Hill	26
Scattering	126
Void	26
Blank	17
Total	472

For Director, District 3

Arthur W. Harrington	63
Roy G. Finch	41
S. C. Hollister	18
Scattering	7
Blank	6
Total	135

For Director, District 5

James A. Anderson	60
William H. McAlpine	5
Scattering	11
Void	9
Blank	1
Total	86

For Director, District 7

Louis E. Ayres	93
Scattering	9
Void	16
Total	118

For Director, District 8

W. W. DeBerard	48
Wilbur M. Wilson	10
Scattering	12
Void	24
Total	94

For Director, District 9

Wendell P. Brown	51
Joseph E. Root	50
Scattering	9
Void	9
Total	119

For Director, District 12

Ross K. Tiffany	84
Scattering	5
Void	3
Blank	2
Total	94

For Director, District 16

Thomas R. Agg	68
Lowell E. Conrad	61
Scattering	9
Void	11
Total	149

Respectfully submitted,
DEAN G. EDWARDS, *Chairman*

Malcolm S. Spelman
A. A. Dedouloff
Joseph Fertik
James McB. Webster
Lewis Kuhl, Jr.
Frederick C. Lowy
James I. Rooney
Thomas K. A. Hendrick
Charles W. Comstock
R. G. Waggener
Tellers

Appointments of Society Representatives

SAMUEL A. GREELEY, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on the Washington Award Commission, to serve for the two-year term beginning August 1, 1937.

HENRI E. GRUNER and KARL E. HILGARD, Members Am. Soc. C.E., were appointed Society delegates to the centenary celebration of the Société Suisse des Ingénieurs et des Architects at Berne, Switzerland, September 4–5, 1937.

OTIS E. HOVEY, M. Am. Soc. C.E., has been reappointed to represent the Society on the United Engineering Trustees Inc., for the three-year term beginning in October 1937.

J. P. H. PERRY, M. Am. Soc. C.E., has been reappointed one of the Society's representatives on Engineers' Council for Professional Development tor the three-year term beginning in October 1937.

FRED C. SCOBEY, M. Am. Soc. C.E., will represent the Society on the Research Procedure Committee of the Engineering Foundation.

Boston Meeting in the Offing

Just ahead of the Society Affairs section in this issue will be found the program for the Fall Meeting of the Society, which is to convene in Boston on October 6, 1937. A glance at its pages will reveal a well-rounded group of technical sessions calculated to appeal to engineers in all lines of work, and a series of social events of various sorts for both members and their women guests.

The cooperation of the Engineering Institute of Canada will give the meeting added interest. A large number of members of that organization are expected to attend, and the Institute will have complete charge of one of the sessions.

Many who attend the meeting will doubtless wish to extend their stay to take advantage of the autumn vacation attractions of New England. The publishing of the program a month earlier than is customary should make it possible for even the most distant members to lay their plans for such a trip.

Board Action on Federal Work Relief

The present and future of government work relief activities were subjects of discussion during the recent meeting of the Board of Direction in Ann Arbor, Mich., where, on July 20, the following resolution was adopted:

"Whereas: There is ample evidence to justify a belief that business recovery is advancing to such an extent as to warrant a substantial curtailment of federal work relief activities, and

"Whereas: The complete return to normal conditions should bring about the complete discontinuance of all work and relief agencies supported by federal funds,

"*Therefore, be it resolved:* That the Board of Direction of the American Society of Civil Engineers places itself on record urging that the WPA and PWA activities be liquidated as expeditiously as possible, and

"*Be it further resolved:* That the Secretary of the American Society of Civil Engineers be authorized and instructed to make this resolution public and furnish copies thereof to the President of the United States, to the members of the United States Congress, and to the Administrator of the Federal Public Works Administration and of the Works Progress Administration."

Engineers and the Union Movement

Talk Before the Local Sections Conference at Ann Arbor, Mich., July 20, 1937

By Van Tuyl Boughton, M. Am. Soc. C.E.

Managing Editor, "Engineering News-Record,"
New York, N.Y.

Unionization of engineers and technical men has passed out of the stage of theoretical discussion; it is now a practical problem to be met. In some respects it is comparable to the licensing movement; hence we may learn something from the profession's early experience with licensing.

Licensing was taken up first by the younger and less conservative men in the profession, men who were dissatisfied with existing conditions and who saw in it an opportunity to improve their economic status. It was strongly opposed at first by the older and more conservative men, and as a result the early laws were defective and poorly drafted. Should we not now assume that the profession is going to have unionization of the subprofessional men, and possibly of the junior engineers, and working from that assumption explore the possibilities of such unionization and plan to meet them?

In saying this I do not mean that the engineering profession should go in for unionization, for the two are incompatible. One cannot be a professional man and a union man at the same time. But a man can be an engineer and a union man at the same time, and it is this distinction that needs to be recognized, much as we may not like the idea.

We like to think of all engineers as professional men, but in many large organizations there are engineers employed in jobs requiring such a limited amount of engineering skill and initiative that they can hardly be classed as professional. Yet many of the men holding these jobs are licensed as engineers; some are trained to fill better jobs. Working close to them are draftsmen, computers, and tracers, many of whom have a little knowledge of engineering but like to think that they are engineers or will be some day.

Whenever the number is large enough to eliminate the close personal contact between employer and employee that exists in small engineering organizations, the door is opened to unionization. In these large organizations the men become part of a machine just as do the skilled mechanics in the highly unionized trades, and it is difficult to develop and maintain personal interest in the success of the job that is found in the smaller office.

But until the advent of the NRA and the passage of the Wagner Act the chance that unionization of these men could be of serious concern to their employers was remote, chiefly because such men form a small group numerically and are widely scattered. Unions for such men have existed for a long time but have made little headway. Now the situation has completely changed. The Wagner Act gives every group of employees, no matter how small, the right to collective bargaining.

There is a side to the unionization movement that is disconcerting: that is the drive to force engineers into unions whether they will or not. This has been done in several instances in which vertical unions are being organized in a company or industry. There is good reason to believe that in companies with vertical unions many engineers will be led into joining that union under the impression that if they do not no one will take any interest in their particular troubles, or even that they may lose their jobs, though there seems to be no legal reason for an interpretation of the act that joining a union is compulsory.

Thus it appears evident that the movement to unionize engineers and subprofessional groups in engineering will continue to gain headway. How much headway, is up to the profession itself to decide.

Local Section Action

What can the Local Sections do about it? I do not profess to have an answer to that question, but hope to indicate some ways in which the Sections can help. Back of every unionization movement is dissatisfaction with existing conditions, a feeling that no one is interested in getting better pay or better working conditions for the individual. Here the engineering societies can help by showing an interest in the economic condition of the young engineer. The Society, through the activities of its Committee on Salaries, has done a lot towards setting up minimum rates and in getting them made effective. The local Sections can do more in this field than they have. Regional scales of rates for all the principal grades of engineering work are highly desirable but should be kept in close relation to nationally accepted scales. Local Sections now can make a valuable contribution, both to the interest of the younger men as well as to the employers, by setting up such scales and working for their adoption.

Local Sections could go farther; they could set up grievance committees to take up the troubles of the young men when they feel that they are underpaid or overworked—committees that would go directly to their employers when sure of their ground. Such work could best be done in cooperation with local professional societies. Probably the best way to keep men from feeling that they need to be in a union to advance their economic position is to stimulate their interest in the profession, first through promoting closer contact with the older men, and second by making them a more important part of the professional group through active participation in Local Section affairs.

Obviously, in the larger cities, where unionization is likely to be most active, the Local Sections of the Founder Societies cannot reach all the young engineers, but they will reach those who are likely to be most influential with the younger group if they set out to interest their Junior members. In the Metropolitan Section one Junior is put on each standing committee, and the Junior Branch is now well established, active, and growing. Recently the Section's Committee on Professional Relations asked the Junior Branch to make a study of the New York License Law and its system of examinations in order to get the views of the men now most affected by the laws. Such assignments give the young men a definite interest.

Looking ahead, what should we plan for? Fundementally, it is to keep the young men interested in developing into elements of a profession in which each individual stands on his own feet.

American Engineering Council Reports on Government Fees for Consultants

By special request of the Society, American Engineering Council has prepared a report on "Fees for Engineering Services—An Examination of Practices Among Government Agencies." A limited number of copies are available, and can be obtained by writing to American Engineering Council at 744 Jackson Place, Washington, D.C.

The report covers the regulations and procedures affecting the engagement of technical talent by government agencies on a contract, per diem, or percentage fee basis; the present compensation schedule and methods of determining fees; and the extent to which various agencies make use of outside engineering advice and assistance.

Practices in the various agencies vary greatly, but may be grouped roughly in two categories. In the first (which may be called the "normal" procedure), "fees are usually fixed by simply dividing the salary of the head of the bureau by 360 and calling the result a suitable (per diem) fee." In the second, the government negotiates with consulting engineers and contracts for their services "in much the same manner as private employers do, and on practically the same general basis of contract, except for compensation, as that found acceptable in private business."

The Corps of Engineers, U.S.A., the TVA, and the Procurement Division and the Bureau of Internal Revenue of the Treasury make frequent use of expert advice and assistance. The Corps of Engineers contracts for services at from $50 to $75 per day plus $5 for subsistence and actual traveling expenses. The TVA per diem payments vary from $50 to $25 or less. The usual payment in the Treasury organizations is $25 plus subsistence and travel, though on rare occasions the Bureau of Internal Revenue has paid as much as $100.

The AAA and FCC do not employ expert advice on a per diem or contract fee basis; "experts" are carried as regular or temporary employees, and compensation is in accordance with Civil Service schedules. The usual limit, on a per diem basis, with FCA, PWA, and SEC, is $25 plus subsistence and travel, though PWA may go as high as $50. RFC usually pays $32.50 on the same basis, but in some instances contracts for services on a fee basis, with a maximum of $50 per day including expenses. The $50 limit also governs the Bureau of Reclamation. The National Resources Committee pays from as much as $50 to as little as $10 per day, averaging about $25.

Among the government agencies making no use of outside consultants are the Bureau of Mines, Bureau of Public Health Service, Coast and Geodetic Survey, FHA (of itself), RA (at present), Soil Conservation Service, and WPA. Agencies listed as seldom employing outside consultants include the Bureau of Public Roads, Bureau of Yards and Docks of the Navy Department, Federal Trade Commission, and REA.

Council's report was reviewed by all of the members of the Society's Committee on Fees. Thereafter the committee wrote to Frederick H. Feiker, executive secretary of Council, expressing its opinion that the report brought out forcefully "the highly unsatisfactory conditions existing in the procedure of the federal government," due to the lack of uniformity and the uncertainty of procedure, and suggesting that "a tactful endeavor to remedy the undesirable features of this procedure should be undertaken." Specifically it was suggested that the attitude of certain government agencies towards the adoption of a standard procedure for the engaging of professional services should be ascertained.

In accordance with this suggestion Council discussed the matter further with the Corps of Engineers and two other agencies. According to Mr. Feiker (in a letter of July 10), the officer of the Corps with whom the discussion was held stated that "the Army engineers are not selecting consulting engineers on a competitive bidding basis," but that, on the contrary, "the Chief of Engineers wishes to be free to select the most desirable consulting advice for each undertaking and hopes that he may never be forced to use the services of the lowest bidder regardless of qualifications or reputation.... In most instances the District Engineer is authorized to contact two or more consulting engineers, satisfactory to the Chief of Engineers, and negotiate with such engineers for their services in much the same way as private enterprise would do."

On those projects where there is a definitely defined piece of design or other specified engineering work to be done, the Engineer Corps endeavors to get a lump sum price, but "the business seldom goes to the engineer who is willing to make the lowest price. It is claimed that fitness is of first importance, that availability and familiarity with the particular problem comes second, and that price is the last consideration except in rare instances where men of equal qualifications are seeking the business."

"The evidence submitted to us," continued Mr. Feiker, "indicates that outside engineering advice and assistance is more frequently retained on a per diem plus expense basis. Since Council began contacting the Engineer Corps about the matter of more adequate compensation the fee has been raised in two instances to $75 per day. . . .

"In only a few cases is the Engineer Corps reported to have retained engineering services on a percentage basis. When the work is done that way, it is claimed that the work is let to one of the engineers believed to be best qualified to design and supervise, and not to the lowest bidder unless he be of equal or superior fitness. Under this procedure, as well as those referred to above, the Engineer Corps is governed by the law authorizing the work and making appropriation for it."

Mr. Feiker concluded his supplementary report as follows:

"Almost everyone of the officials contacted seemed perfectly willing to pay reasonable fees and anxious to keep or to get authority to negotiate for the services of one of the best engineers available for the work, as it develops. Several expressed the hope that nothing would be done to standardize fees in the lower brackets and thus compel the federal government to use only the services of those engineers who would accept smaller fees from government agencies because they could not compete successfully for a satisfactory volume of business in private practice."

The Board of Direction of the Society considered this report and the supplementary correspondence at its Ann Arbor meeting in July, and passed the following resolution:

"That the Secretary be instructed to write Mr. Feiker thanking him for his efforts and the excellent results of his discussions and negotiations with federal officials relative to the engaging of professional engineering services by the government, and compensation for such services on both a per diem and lump sum or percentage basis; and that the Secretary advise Mr. Feiker that the Board is gratified with the attitudes and expressions of policy outlined in Mr. Feiker's letter of July 10, 1937, as representing the present views of the three federal departments interviewed, with the request that Mr. Feiker convey in writing to these departments the gratification felt by this Board and its hope that the several departments of the federal government employing engineers will always recognize the importance of engineering experience and ability and the unfairness and economic mistake of standardizing engineering remuneration on a per diem basis below that obtaining in private practice or the obtaining of engineering services on a basis of competitive bidding."

Regional Convention to Be Held at Dayton

A regional convention to be held at Dayton, Ohio, on October 14 and 15, 1937, will feature a discussion of flood-control operation and aerial photography. The convention, which will be presided over by R. C. Gowdy, Vice-President of the Society, will be called to order by Bernard T. Schad, president of the Dayton Section, at 10 o'clock Thursday morning. The subject for discussion that day will be "Fifteen Years' Operation of Flood Control in the Miami Conservancy District," and on Friday, "Aerial Photography and the Civil Engineer." A number of inspection trips have been arranged to nearby points of engineering interest. Civil Engineering is indebted to Ernest O. Brown, chairman of the program committee, for the foregoing account. A more extended write-up will appear in the October issue.

Income and Earnings in the Engineering Profession, 1929–1934

Reports from 52,589 professional engineers have made it possible to present what are probably the most comprehensive income data ever prepared for a professional group.

This is the fifth in a series of articles covering the results of the Survey of the Engineering Profession made in 1935 by the Federal Bureau of Labor Statistics at the request of American Engineering Council. It is abstracted from a report of the same title by Andrew Fraser, Jr., of the Labor Bureau.

Previous articles of the series were published in "Civil Engineering" in August 1936, and in February, May, and June 1937.

General Observations

In 1929, 50 per cent of the 30,032 reporting engineers earned more than $3,412 and 50 per cent earned less than that amount. Twenty-five per cent earned more than $5,012, but only 10 per cent had incomes in excess of $7,466 per annum. On the other hand, 25 and 10 per cent of the engineers earned, respectively, less than $2,509 and $1,878 per year.

Comparison of the incomes for 1932 and 1934 with those reported for 1929 shows that from 1929 to 1934, the sharpest absolute declines occurred in the two higher income groups. Their percentage decreases were least, however, averaging 31.2 and 31.6 per cent, whereas the middle values of income declined by 33 per cent, and the two lower levels by 41.3 and 53.6 per cent, respectively. Almost two-thirds of these decreases in earned annual income occurred between 1929 and 1932. Over the period 1929 to 1934, relatively the smallest shrinkages in earnings were reported by the civil engineers, while the chemical and ceramic engineers suffered the greatest cuts.

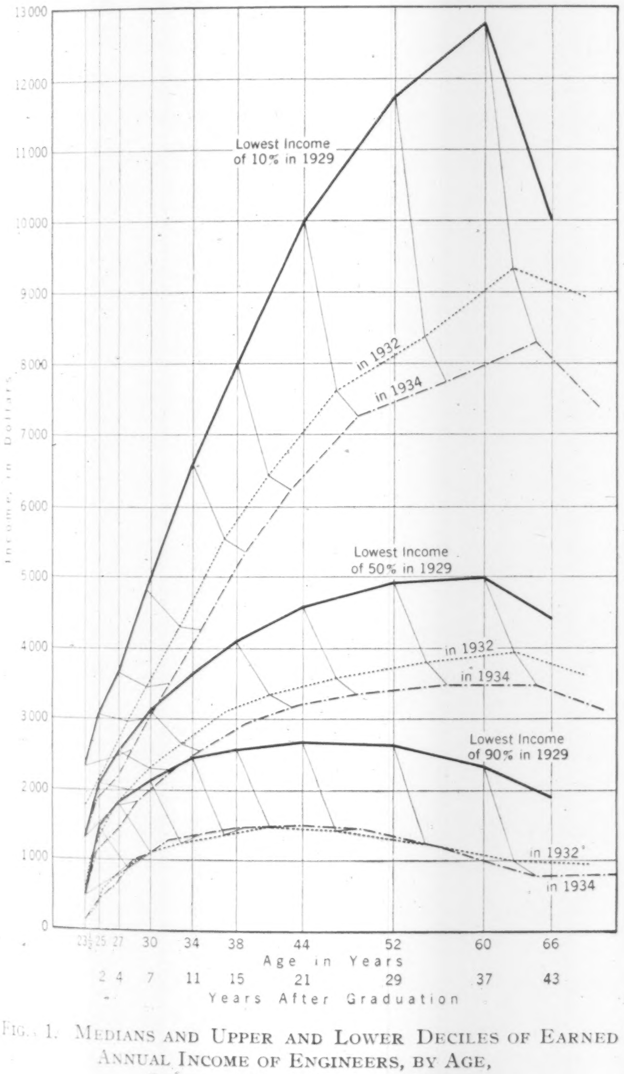


Fig. 1. Medians and Upper and Lower Deciles of Earned Annual Income of Engineers, by Age, During 1929, 1932, and 1934

Income from Engineering and Non-Engineering Services, Including Full and Part-Time Employment, All Types of Education

Among the several professional classes, the divergences in earning capacities are most marked in the higher levels of income. For example: In 1929, 10 per cent of the mining and metallurgical engineers earned more than $9,912 per year, while the minimum earnings for the upper 10 per cent of the civil engineers amounted to only $6,507.

Earnings appear to advance with age in three distinct phases. There is an initial period of exceptionally rapid rise, followed by two others of slower rates of increase. The age spans of these phases varies with the income level. The earnings of the engineers in the lower income levels cease to increase at a relatively early age. They show a level period before beginning to decline, whereas the higher levels of income show continuous increases for a considerably longer period, after which, however, they decline at a much greater rate.

Comparison of the earnings of engineers of identical ages in 1929 and 1934 shows that the average income of engineers who had been out of college for 2 years declined 43 per cent. The income of those who had been out 5 years declined 35 per cent. For older engineers the decline approximated 30 per cent.

Consideration of the incomes reported by engineers of different educational backgrounds shows that those with a formal engineering education did receive a higher income. The differentials in earnings, however, did not accrue in equal measure for all five professional classes.

At about 28 years of age engineers without formal engineering education had lost their initial advantage in earning capacity. With advancing age, the spreads in earnings in favor of the graduates became very marked indeed. For example, at 5, 20, and 37 years after graduation, the earnings of mechanical and industrial engineers exceeded by $175, $925, and $1,322 per year those of the engineers of the same professional class whose college course was incomplete and surpassed by $225, $1,160, and $1,815 per year those of engineers with a non-collegiate technical school education. In general, the earnings of the latter group ceased to increase at an earlier age than those of the graduates.

Earned Annual Income

Analysis was made to determine the changes in the income and earnings of professional engineers during the period 1929 to 1934. The reports covered two distinct features of income for the years 1929, 1932, and 1934: (1) Earned annual income received from all personal services, and (2) average monthly compensation from engineering work only. The annual figures are a measure of what engineers were able to earn during each of the three years. This was determined not only by the rate of earnings but also by the volume of employment.

Table I shows five levels of annual earnings in each of the five professional classes in 1929, 1932, and 1934. When the question is asked as to which professional class offers the greatest earnings, or which the lowest, the answer must be carefully qualified. In the first place, the averages shown in Table I relate to the total number in the professional class. For example, 1,319 mining and metallurgical engineers reported incomes for 1929, and of these one-tenth, or 132 had incomes of $9,912 or more. There were 13,424 civil, agricultural, and architectural engineers, of whom one-tenth, or 1,342, had incomes in excess of $6,507. Therefore, it may be concluded that of every 1,000 engineers in either professional class, a larger proportion will earn $10,000 in mining and metallurgical engineering than in civil engineering. But the total number of opportunities to earn $10,000 were greater in civil engineering, much the larger of the two professional classes. Among the civil engineers, there were 469 who indicated incomes of $10,000 or more in 1929.

Again, the ranking of the profession on the basis of earnings opportunity relative to the number of engineers in the professional class was not the same at all levels and in all three periods. At the lower levels the most marked shift in rank was that of civil engineers and chemical engineers. In 1929, one-quarter of the civil

Table I. Comparison of Five Levels of Annual Earnings for All Engineers Reporting in Each Professional Class in 1929, 1932, and 1934

[Figures Derived Without Regard to Employment Status Reported or Type of Education]

Per Cent of Professional Class at Specified Income Level*	Annual Earnings of More Than Specified Amount			Increase or Decrease			Per Cent of Change		
	1929	1932	1934	1929–1934	1929–1932	1932–1934	1929–1934	1929–1932	1932–1934
10 per cent:									
Mining and metallurgical	$9,912	$7,011	$6,486	−$3,426	−$2,901	−$525	−34.6	−29.3	−7.5
Chemical and ceramic	9,103	6,525	5,860	−3,243	−2,578	−665	−35.6	−28.3	−10.2
Mechanical and industrial	8,508	6,220	5,572	−2,936	−2,288	−648	−34.5	−26.9	−10.4
Electrical	7,185	5,785	5,220	−1,965	−1,400	−565	−27.3	−19.5	−9.8
Civil, agricultural, and architectural	6,507	5,086	4,561	−1,946	−1,421	−525	−29.9	−21.8	−10.3
25 per cent:									
Mining and metallurgical	6,301	4,698	4,328	−1,973	−1,603	−370	−31.3	−25.4	−7.9
Chemical and ceramic	6,043	4,425	3,703	−2,340	−1,618	−722	−38.7	−26.8	−16.3
Mechanical and industrial	5,582	4,123	3,662	−1,920	−1,459	−461	−34.4	−26.1	−11.2
Electrical	4,806	3,770	3,410	−1,396	−1,036	−360	−29.0	−21.6	−9.5
Civil, agricultural, and architectural	4,508	3,579	3,266	−1,242	−929	−313	−27.6	−20.6	−8.7
50 per cent:									
Mining and metallurgical	4,010	3,061	2,626	−1,384	−949	−435	−34.5	−23.7	−14.2
Chemical and ceramic	3,803	2,625	2,047	−1,756	−1,178	−578	−46.2	−31.0	−22.0
Mechanical and industrial	3,699	2,681	2,324	−1,375	−1,018	−357	−37.2	−27.5	−13.3
Civil, agricultural, and architectural	3,291	2,545	2,297	−994	−746	−248	−30.2	−22.7	−9.7
Electrical	3,277	2,509	2,218	−1,059	−768	−291	−32.3	−23.4	−11.6
75 per cent:									
Mining and metallurgical	2,839	1,788	1,512	−1,327	−1,051	−276	−46.7	−37.0	−15.4
Mechanical and industrial	2,626	1,676	1,424	−1,202	−950	−252	−45.8	−36.2	−15.0
Chemical and ceramic	2,538	1,556	1,213	−1,325	−982	−343	−52.2	−38.7	−22.0
Civil, agricultural, and architectural	2,499	1,770	1,596	−903	−729	−174	−36.1	−29.2	−9.8
Electrical	2,339	1,634	1,343	−996	−705	−291	−42.6	−30.1	−17.8
90 per cent:									
Mining and metallurgical	1,985	773	893	−1,092	−1,212	+120	−55.0	−61.1	+15.5
Mechanical and industrial	1,956	919	853	−1,103	−1,037	−66	−56.4	−53.0	−7.2
Civil, agricultural, and architectural	1,926	909	1,016	−910	−1,017	+107	−47.2	−52.8	+11.8
Chemical and ceramic	1,686	732	610	−1,076	−954	−122	−63.8	−56.6	−16.7
Electrical	1,662	873	731	−931	−789	−142	−56.0	−47.5	−16.3

* Arranged in descending order of earned annual income for 1929.

engineers earned less than $2,499, exceeding only the comparable earnings of electrical engineers. But in 1932, civil engineers were in second place as regards the level of earnings of the lowest quarter of the profession, and in 1934 they were in first place.

ANNUAL INCOME RELATED TO AGE

The effects of age upon earned annual incomes, for engineers in all professional groups combined are presented in Table II.

Changes in income brought about by the depression in various years may be considered from the point of view of particular individuals whose age and experience were increasing, or from the point of view of the expectations of men with comparable periods of experience. For example, the average earnings of engineers who graduated in 1927–1928 declined only from $2,098 in 1929 to $2,020 in 1932, and increased slightly to $2,023 in 1934. On the other hand, those who graduated in 1897–1904 averaged $4,918 in 1929, $3,832 in 1932, and $3,502 in 1934. Such comparisons for each group of engineers over the period 1929–1934 may be made from Table II. For three of the groups, however, they are more conveniently arranged for direct comparison in Fig. 1.

This figure shows a rise in earnings for the youngest engineers in the profession in 1929, who were near to 30 years of age in 1934. The advance in earning capacity in the first five years of engineering experience was so great that it offset the influence of the depression in the case of the youngest engineers. At higher ages, when an added year's experience influenced income less, the incomes of particular engineers were found to have declined by as much as 30 per cent for the average graduate of the class of 1889–1896.

The most significant differences brought about by the depression were in the spread of incomes at various ages. In all cases, primarily because of the influence of unemployment, annual income

Table II. Comparison of Five Levels of Annual Earnings on Age Basis for All Engineers Reporting in 1929, 1932, and 1934

[Without Regard to Employment Status Reported or Type of Education]

Age	Year of Graduation	Years After Graduation	Proportion with Annual Earnings of More Than Specified Amount				
			10 %	25%	50%	75%	90%
		1929					
64 years and over	Prior to 1889	41 and over	$9,999	$6,942	$4,427	$3,005	$1,904
56–63 years	1889–96	33–40	12,749	7,493	4,968	3,378	2,328
48–55 years	1897–1904	25–32	11,701	7,129	4,918	3,471	2,621
40–47 years	1905–12	17–24	9,913	6,473	4,588	3,403	2,683
36–39 years	1913–16	13–16	7,936	5,802	4,121	3,210	2,563
32–35 years	1917–20	9–12	6,520	4,850	3,674	3,004	2,448
28–31 years	1921–24	5–8	4,797	3,786	3,145	2,567	2,130
26–27 years	1925–26	3–4	3,621	3,099	2,550	2,149	1,827
24–25 years	1927–28	1–2	3,049	2,497	2,098	1,822	1,462
23 years	1929	0	2,330	1,922	1,313	882	478
		1932					
67 years and over	Prior to 1889	44 and over	8,940	5,931	3,650	2,104	953
59–66 years	1889–96	36–43	9,318	6,167	3,959	2,462	964
51–58 years	1897–1904	28–35	8,350	5,753	3,832	2,525	1,219
43–50 years	1905–12	20–27	7,570	5,192	3,619	2,520	1,410
39–42 years	1913–16	16–19	6,395	4,592	3,385	2,475	1,478
35–38 years	1917–20	12–15	5,519	4,115	3,135	2,307	1,355
31–34 years	1921–24	8–11	4,287	3,386	2,677	2,025	1,229
29–30 years	1925–26	6–7	3,428	2,862	2,314	1,810	1,110
27–28 years	1927–28	4–5	2,970	2,452	2,020	1,504	876
26 years	1929	3	2,451	2,075	1,772	1,271	735
25 years	1930	2	2,139	1,898	1,540	1,007	577
24 years	1931	1	1,960	1,605	1,224	733	293
23 years	1932	0	1,673	1,097	645	322	129
		1934					
69 years and over	Prior to 1889	46 and over	7,360	5,182	3,138	1,470	787
61–68 years	1889–96	38–45	8,280	5,391	3,497	1,800	770
53–60 years	1897–1904	30–37	7,720	5,264	3,502	2,165	1,157
45–52 years	1905–12	22–29	7,226	4,907	3,380	2,364	1,441
41–44 years	1913–16	18–21	6,204	4,441	3,211	2,256	1,491
37–40 years	1917–20	14–17	5,336	3,953	2,977	2,173	1,463
33–36 years	1921–24	10–13	4,259	3,334	2,569	1,958	1,358
31–32 years	1925–26	8–9	3,496	2,840	2,294	1,817	1,276
29–30 years	1927–28	6–7	3,004	2,467	2,023	1,568	1,061
28 years	1929	5	2,567	2,162	1,858	1,431	998
27 years	1930	4	2,318	1,987	1,666	1,256	865
26 years	1931	3	2,100	1,816	1,441	1,067	631
25 years	1932	2	1,952	1,581	1,275	945	495
24 years	1933	1	1,801	1,454	1,139	813	333
23 years	1934	0	1,310	927	598	299	120

TABLE III. COMPARISON OF FIVE LEVELS OF EARNED ANNUAL INCOME FOR GRADUATE* AND "OTHER"† ENGINEERS REPORTING IN EACH PROFESSIONAL CLASS AT END OF 1929, 1932, AND 1934

[Includes Only Engineers Who Were Professionally Active Prior to 1930]

PER CENT OF PROFESSIONAL CLASS‡ AT SPECIFIED INCOME LEVEL	ANNUAL EARNINGS OF MORE THAN SPECIFIED AMOUNT						PER CENT INCOME OF "OTHER" ENGINEERS FORMED OF THAT OF GRADUATE ENGINEERS		
	Graduate Engineers*			"Other" Engineers†					
	1929	1932	1934	1929	1932	1934	1929	1932	1934
10 per cent:									
Mining and metallurgical	$10,015	$7,413	$7,530	$8,940	$6,370	$6,263	89	86	83
Chemical and ceramic	9,173	7,432	7,414	8,100	6,435	6,795	88	87	92
Mechanical and industrial	8,715	6,481	6,269	8,161	6,273	5,997	94	97	96
Electrical	7,301	6,263	6,084	6,654	5 943	5,670	91	95	93
Civil, agricultural, and architectural	6,853	5,478	5,133	5,745	4,470	4,222	84	82	82
25 per cent:									
Mining and metallurgical	6,349	4,973	4,833	6,025	4,640	4,587	95	93	95
Chemical and ceramic	6,111	5,116	4,976	5,210	4,540	4,335	85	89	87
Mechanical and industrial	5,603	4,414	4,262	5,536	4,269	3,972	99	97	93
Electrical	4,886	4,175	4,062	4,497	3,762	3,654	92	90	90
Civil, agricultural, and architectural	4,732	3,923	3,671	4,036	3,349	3,163	85	85	86
50 per cent:									
Mining and metallurgical	4,053	3 299	3,227	3,762	3,082	3,072	93	93	95
Chemical and ceramic	3,839	3,368	3,308	3,525	3,050	2,857	92	91	86
Mechanical and industrial	3,663	3,025	2,848	3,777	2,929	2,645	103	97	93
Civil, agricultural, and architectural	3,375	2,834	2,636	3,099	2,530	2,362	92	89	90
Electrical	3,296	2,863	2,821	3,213	2,627	2,517	97	92	89
75 per cent:									
Mining and metallurgical	2,841	2,013	2,029	2,829	2,013	1,947	99	100	96
Mechanical and industrial	2,556	1,981	1,952	2,902	1,930	1,837	114	97	94
Civil, agricultural, and architectural	2,541	2,009	1,956	2,429	1,860	1,747	96	93	89
Chemical and ceramic	2,538	2,178	2,195	2,540	1,885	1,834	100	87	84
Electrical	2,317	1,997	2,003	2,400	1,883	1,792	104	94	89
90 per cent:									
Mining and metallurgical	1,977	1,052	1,279	2,030	1,210	1,283	103	115	100
Civil, agricultural, and architectural	1,935	1,136	1,361	1,910	1,028	1,152	99	90	85
Mechanical and industrial	1,888	1,212	1,245	2,170	1,040	1,169	115	86	94
Chemical and ceramic	1,657	1,443	1,458	1,820	699	783	110	48	54
Electrical	1,609	1,311	1,308	1,860	1,185	1,088	116	90	83

* Graduate engineers embrace all postgraduates, non-engineering graduates, and first-degree engineering graduates.

† "Other" engineers embrace all engineers with college course incomplete, non-collegiate technical school course and secondary school education.

‡ Arranged in descending order of graduate earned annual income for 1929.

for the lowest 25 per cent and the lowest 10 per cent declined more than the average income at a given age.

ANNUAL INCOME AND EDUCATION

The foregoing analysis takes no account of differences in educational background. A comparison of the earnings of graduate engineers and "other" engineers in the various professional classes is given in Table III. Consideration of the ratios derived from the 1929 earnings reported by the "other" and graduate engineers clearly indicates that those with a formal engineering education had higher incomes. It will, however, be noted that there were wide variations in the ratios in the earnings of the two groups, indicating that the differentials in earnings do not accrue in equal measure for all five professional classes.

Table IV shows the rank of engineers of specified education, in various age-groups, as to annual earnings in 1934. It will be observed that the "other" engineers, at a very early age lose the advantage in earning capacity that they have gained from practical experience while the college graduate is still in school. Relatively, the greatest shifts in position occurred between the second and fifth years after graduation.

CAUTIONS ON USE OF DATA

It cannot be too strongly emphasized that these data relate only to what engineers of various ages were earning in 1929, 1932, and 1934. A cautious use of such information may add to the value of the advice of those who are directing young men into the various fields of specialization. A careless assumption that this same relationship will hold 20 years hence for future graduates will make the resulting advice dangerous.

The tabulations show merely the facts of the income distribution in 1934 or some other particular year. For example, chemical and ceramic engineers 20 years after graduation averaged $4,100 and one-quarter of such engineers earned more than $6,000. On the other hand, civil engineers 20 years after graduation averaged $3,100 and the best-paid quarter averaged only $4,100 or more. But it must not be concluded from these data on income alone that it is wise to encourage men entering college in 1937 to specialize in chemical and ceramic engineering and to discourage their entering the field of civil engineering. It is quite possible that there may be a relative scarcity of engineers with a given type of academic background and with 20 years of experience, while at the same time the supply of younger engineers with that same type of formal education may have become excessive. It is quite easy to see that a special scarcity value may have attached in 1934 to chemical engineers that did not accrue to civil engineers graduating in 1914. There was a tremendous expansion of the chemical industry in the United States during and following the war, and such enterprises had the greatest difficulty in finding sufficient men with the requisite education and experience. On the other hand, while there are more civil engineers and more jobs for civil engineers than in 1914, a decrease in certain types of civil engineering work—as, for example, the construction of new railroads—has acted to restrain the development of relative scarcity values such as may have attached to chemical engineers.

At the same time it is impossible to make a comparison of the earnings of the younger engineers in the several professional classes and to conclude that the relationship between the professional groups will hold when they have had 20 years' experience. The statistics do not preclude the possibility that there is a longer period of apprenticeship for some types of engineering work than for others and that, following such a period of apprenticeship, there may be a more rapid advancement in the one line than in the other, ultimately to a higher level of income.

Conclusions as to the relative desirability of entering one type of engineering rather than another should be drawn only by those with an intimate acquaintance with all fields of engineering. Available statistics are probably a less satisfactory basis for advice than would be the pooled non-statistical judgments of a number of people with a wide knowledge of the engineering profession and its opportunities. The statistical materials of this study can be used safely in projection only to fortify the judgments and forecasts of such individuals.

VALUE OF A COMPLETED COLLEGE COURSE

The Bureau has carefully refrained in this article from describing differences in the average incomes of graduate and non-graduate engineers as a measure of the value of a completed college course in engineering. From the data in hand, it is impossible to determine whether the differences are due to the fact that given individuals have received a college education or to other factors. It is possible that the differences in income arise from an initial process of selection—that a prejudice in favor of the college graduate affords him better opportunities to acquire valuable experience than are given to the non-college graduate. In such case, the advantages would arise not from formal education which the man had received but from his status as a college graduate.

It is a matter of common belief that college training has economic value for the prospective engineer. The figures in this study support this belief but cannot be taken as conclusive proof. Rather more conclusively they prove the great importance of other factors in addition to formal education. If formal education is an asset, the young graduate engineer should advance more rapidly than the non-graduate of corresponding age. This does happen. But were formal education an all-important element in determining income in these early years, there should come a point at which no further relative spread developed between the average earnings of college graduates and non-graduates. However, there is no such point.

The difference is greater both in absolute terms and in relative terms after 30 or 40 years of experience than it is after 10 or 15 years of experience.

It can hardly be argued that the scholastic background of engineers who entered the profession in 1900 is a controlling factor with reference to their earnings in 1929 and 1934. Certainly, the value of their services is no longer primarily dependent upon the odds and ends of information which they acquired in college, although it is possible that habits of thinking and study which the engineer received in his college days constitute a permanent legacy.

As regards native capacity, there is reason to believe that, on the average, better material will be found among college graduates than among those who failed to complete a college course. There is a wholesale process of weeding out that goes on in the engineering schools. Thus even the differences in income shown in the earliest years of experience may reflect differences in capacity rather than differences arising from the value of the formal training.

TABLE IV. RANK OF ENGINEERS OF SPECIFIED EDUCATION ACCORDING TO MEDIAN ANNUAL EARNINGS IN 1934, FOR CORRESPONDING YEARS AFTER GRADUATION

[Without Regard to Employment Status Reported]

TYPE OF EDUCATION	YEARS AFTER GRADUATION											
	Rank in 1934						Annual Earnings in 1934					
	2	5	10	20	30	37	2	5	10	20	30	37
Secondary school education	1	9	9	8	9	8	$1,550	$1,625	$2,025	$3,031	$3,200	$3,350
Non-collegiate technical course: Mechanical and others*	2	12	10	10	10	10	1,475	1,475	2,010	2,713	3,150	2,980
College course incomplete: Mechanical and others*	3	10	8	9	7	9	1,350	1,600	2,200	2,990	3,490	3,200
Non-collegiate technical course: Civil, agricultural, and architectural	4	2	12	12	12	12	†	1,830	1,900	2,420	2,490	2,490
First-degree engineering graduates: Civil, agricultural, and architectural	5	5	7	7	8	7	1,325	1,800	2,350	3,129	3,300	3,400
College course incomplete: Civil, agricultural, and architectural	6	11	11	11	11	11	1,300	1,600	2,000	2,496	2,780	2,790
Non-engineering graduates	7	3	3	1	2	3	1,275	1,825	2,600	4,467	4,250	4,400
First-degree engineering graduates:												
Chemical and ceramic	8	1	1	2	1	1	1,250	1,875	2,750	4,111	5,050	†
Mining and metallurgical	9	7	4	4	5	5	1,200	1,700	2,550	3,588	3,980	4,050
Mechanical and industrial	10	4	6	5	6	6	1,180	1,825	2,490	3,538	3,780	3,880
Electrical	11	8	5	3	3	4	1,080	1,650	2,500	3,917	4,250	4,325
Postgraduates	12	6	2	6	4	2	940	1,750	2,610	3,517	4,175	4,425

* Includes chemical, ceramic, electrical, industrial, mining, and metallurgical engineers.

† Less than 10 engineers reported.

Many large employers of young engineers have already developed a highly selective process of employment in interviewing candidates from engineering colleges. They may assume that in general college graduates are more promising material than non-graduates. But they no longer recognize the mere fact of graduation as evidence of employability; they now give special status only to those who graduate with a standing substantially better than the average of the class. Thus the advantage of status which may have accrued a number of years ago through the fact of college graduation alone now accrues in equal measure only to graduation with exceptional standing.

The most significant differences in income revealed by the present survey are not the differences in the average income received by individuals who have received a college degree and those who have not. Nor are they the differences as between individuals who have entered one professional class rather than another. The most striking differences are those which exist within each profession and within each group classified on the basis of its educational background. One out of 10 of the engineers in each such group secures an income several times as great as the average for the group as a whole. At least one out of 10 at the bottom of each such group, whether a college graduate or not, whether a chemical engineer or a civil engineer, whether a man with many years of service or freshly out of college, is hardly to be distinguished as regards income from a skilled wage earner.

We do not feel ourselves competent to project from these data what the future holds in store for the high-school boy who must be advised as to what type of training will be most advantageous. We dare do no more than point out that in 1929 the average income of graduate engineers with 10 years' experience ranged from $3,600 to $4,600 in the various professional classes. In 1929 only 6.4 per cent of the incomes in the United States exceeded $4,000. Furthermore, engineering is a profession in which earning capacity advances and is sustained until late in life. But if in these respects the profession appears attractive on the average, its rewards are not particularly attractive to the poorer or less fortunate engineers. Even in 1929 the lowest-paid 10 per cent of the engineers could hope for no more than $2,500 to $3,000, though they might stay in the profession for 40 years. Judged from the basis of money income, there can be no question but that the best of a group of skilled wage earners are in a better economic position than those who struggle to maintain a position on the fringes of the engineering profession.

The Society Answers Questions

RECENTLY someone who chose not to identify himself telephoned Society Headquarters and asked how to set off a charge of dynamite. His inquiry, for rather obvious reasons, was not answered very definitely—but it set the members of the staff to thinking of the wide variety of requests for information that do receive attention from day to day.

A few months ago, one recalled, someone in the Middle West needed information about a man who had built a bridge in Florida a dozen years before. The builder was not a member of the Society, and it took some time to dig out the data from scattered sources, but it was quickly assembled and forwarded. Incidentally, the file on this inquiry is still open, awaiting the thanks of the inquirer.

More recently, another member of the staff held several conferences with a group of Japanese engineers, and helped them plan an inspection trip that in the next few weeks will carry them over the entire country.

Last month a letter came from an engineer in England, asking for literature on American road-building equipment. In reply, six manufacturers were asked to send him their catalogs. Almost in the same mail were other letters requesting data on subjects as varied as earthquakes, snowslide preventive works, self-anchored suspension bridges, and the treatment of pea-cannery wastes.

Occasionally someone misconstrues the purpose or the limitations of the Society, and tries to get a little professional advice gratis—like the man who wrote asking how to build a small dam. In such cases the inquirer is usually advised to ask some consulting engineer in the vicinity for assistance.

And so it goes. The Society is glad to be of whatever assistance it can in such matters, and from ten to twenty requests for information are received each week. Many of them come from members in foreign countries, or in small towns where the *Engineering Index* and other handy reference aids are obviously not available. If the answer can be given with a moderate amount of research it is supplied directly; otherwise the inquiry is referred to the Engineering Societies Library, which at a moderate hourly charge will carry the investigation as far as may be desired.

FALL MEETING of the Society, October 6–8, 1937, at Boston, Mass.

Preview of Proceedings

By **Harold T. Larsen**, *Editor*

Water and rail transportation, hydraulics, reinforced concrete design, and soil mechanics—these broad subjects form the basis of the papers selected for the September issue of "Proceedings." There will be eight papers, guaranteeing many pages of valuable information to those in almost every field of civil engineering.

Water Transportation in the Mississippi Valley: A Symposium

Since the 1936 Spring Meeting of the Society at Hot Springs Ark., the Waterways Division has encouraged a frank and open discussion and analysis of the problems that seem to keep waterway and rail transportation at loggerheads with each other. The leading proponents of each side of the question presented their views at that meeting. Reporting the technical sessions, the July 1936 issue of Civil Engineering carried an abstract of the paper entitled "The Value of Water Transportation" by Rufus W. Putnam, Am. Soc. C.E., and an abstract of the paper on "The High Cost of Inland Waterway Transportation" by S. L. Wonson, M. Am. Soc. C.E. As abstracted, these contributions served to increase the interest of transportation engineers in this subject, and in the intervening time considerable effort has been made to bring the subject up to date, so that the papers, as published in the forthcoming issue of Proceedings, will constitute a thoroughgoing and complete statement of each author's viewpoint. In this form, there will be virtually no space limitation imposed upon discussers, except in so far as they may tend to expand the scope of discussion defined by the authors.

Towboat Leaving Locks in the Ohio River at Louisville, Ky.

The Value of Water Transportation

The first paper in the symposium—that by Major Putman on "The Value of Water Transportation"—will contain detailed estimates of the cost items in water transportation; and a comparison of different kinds of transportation on the Mississippi River. A large part of Major Putnam's paper is concerned with a technical statement of the conditions under which modern water transportation operates. This is traced through the historic developments, emphasizing the essential differences between waterway problems of earlier generations and those of today. Unit costs under modern operating conditions are given in considerable detail. A view of present-day transportation on the Ohio River at Louisville, Ky., is shown in the accompanying photograph.

The High Cost of Inland Waterway Transportation

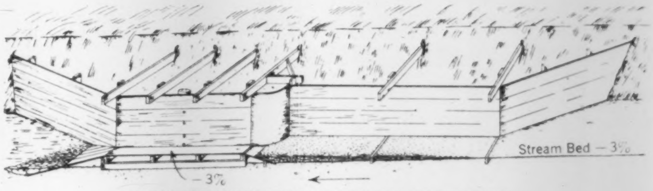
A different viewpoint is expressed by Mr. Wonson in "The High Cost of Inland Waterway Transportation," the second paper in the symposium. His analysis of this subject, supported throughout by quotations from authoritative, independent, and official sources, indicates that certain reasons which may formerly have existed for the fostering of inland waterway transportation are now without validity, and that the transportation problem should be viewed from the standpoint of relative efficiency, taking into consideration all costs on a proper accounting basis.

The paper undertakes to show that so far as the interior transportation needs of the United States are concerned, the rail carriers have certain inherent superiorities over the rivers in transportation efficiency, and that inland waterway transportation exists only by virtue of the so-called hidden costs, which are borne by the taxpayers instead of by those who make use of the service.

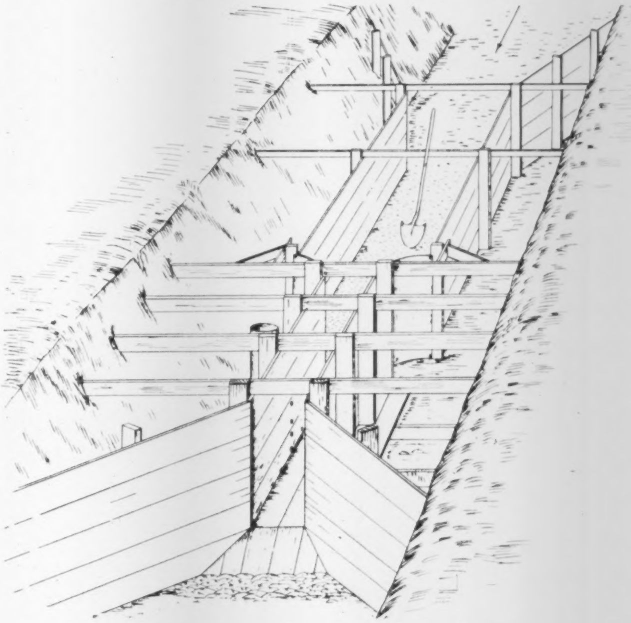
The conclusions are as follows: (1) Projects requiring expenditures for operation and maintenance greater than similar costs of other existing and adequate transportation facilities, should be either retired or transferred from federal interest to such local interests as may be able to operate and maintain them upon an economic basis; (2) projects requiring expenditures for operation and maintenance less than similar costs of other transportation facilities, should, in justice to the taxpayers, carry such service charges to the users as may be equitable; and (3) expenditures for new projects or additional expenditures for existing projects should not be made except on a sound basis of economic justification.

Measurement of Debris-Laden Stream Flow with Critical Depth Flumes

A number of federal agencies are interested in the transportation of debris by the rivers of the United States. Among others may be mentioned the U. S. Bureau of Reclamation and the Soil Conservation Service of the Department of Agriculture, as well as the U. S. Forest Service. For various reasons all these agencies are intensely interested in the development of suitable devices for measuring quantity of flow in small streams that contain detritus. Consequently, a paper on "Measurement of Debris-Laden Stream Flow with Critical Depth Flumes" by H. G. Wilm, John S. Cotton, and H. C. Storey should arouse a great deal of interest.



VIEW OF SECTION ALONG CENTER LINE



Rectangular Critical-Depth Flume

The fundamental problem was to devise a measuring instrument which would handle debris-laden flows successfully. In order to accomplish this purpose, the authors first attempted modification of the flume commonly known as the Parshall measuring flume, and subsequently devised a flume of new design and principle, which appears to function satisfactorily. The features of this instrument consist principally of locating the critical-depth point near the upstream end of the measuring section, thereby producing flow at supercritical velocities, maintaining these velocities by use of a sloping flume floor, and measuring discharge under these conditions of rapid flow. The paper describes the equipment suggested for these experiments, including a number of illustrations and the tables of observational data. The authors make comparisons between the discharges of clear water and discharges of silt-laden water, and discuss in some detail the effect of the various flumes and modifications studied. Modifications to the Parshall flume consist principally of increasing the slope of the bottom, altering the approach wall, and inserting low fillets along the floor. The accompanying isometric views illustrate the new flume design. The experiments were made with flumes varying from 1 to 15 ft in width and for various discharges up to 250 cu ft per sec. The water for these experiments, which was supplied from the San Dimas flood-control reservoir, was run through a series of timber flumes extending over about 200 ft, controlled by various groups of weirs and flumes.

PRE-STRESSED REINFORCED CONCRETE AND ITS POSSIBILITIES

Evidence of the careful consideration given to this paper on "Pre-Stressed Reinforced Concrete and Its Possibilities" by its author, Ivan Rosov, M. Am. Soc. C.E., is seen in the fact that it was reviewed in this column in April 1936. The increasing mass of new data being presented in this field prompted Mr. Rosov to defer publication until the forthcoming issue of PROCEEDINGS, thus insuring the inclusion of evidence which he considered vital to his thesis.

PRACTICAL APPLICATION OF SOIL MECHANICS: A SYMPOSIUM

Progress in the theoretical aspects of the newer science of soil mechanics has reached a stage at which it appears profitable to examine the problems of applying it in actual practice. Four papers have been presented as a symposium, which will have particular interest in view of the emphasis that will be given this subject during the Fall Meeting of the Society, to be held in Boston, Mass., on October 6, 7, and 8. Reprints of this symposium are being ordered for use at this meeting by the new Soil Mechanics and Foundations Division, and anyone interested in obtaining separate extra copies in advance may secure them at a nominal cost by writing Society Headquarters in New York.

LEVEES IN THE LOWER MISSISSIPPI VALLEY

The first in the list of papers on practical applications of soil mechanics is by Spencer J. Buchanan, Assoc. M. Am. Soc. C.E., and is entitled "Levees in the Lower Mississippi Valley." Mr. Buchanan has a good background of theoretical training, practical experience, and observation—hence his suggestions will be well worth considering seriously. In this paper an old problem is attacked in a new manner. It is now feasible by studying the character and limitations of the material conveniently available to the sites, to design and build earth dams and levees by adjusting the slopes and methods of handling to obtain suitable factors of safety.

Mr. Buchanan emphasizes the fact that the design of a levee requires consideration of side slopes, foundations, and the control of seepage, all of which factors are treated in considerable detail. The paper ends with a section on the design of a levee unit including numerical examples.

QUABBIN DIKE BUILT BY HYDRAULIC-FILL METHOD

The subject matter dealt with in the paper, entitled "Quabbin Dike Built by Hydraulic-Fill Method," by Stanley M. Dore, M. Am. Soc. C.E., is of great interest to those concerned with the design and construction of earth dams. The author presents data, by means of which the engineer engaged in constructing a hydraulic-fill dam may regulate and supervise the construction operations. The problem of estimating in advance the rate of consolidation during construction, in an earth-filled dam, is an important one, and Mr. Dore suggests a semi-empirical method which may be used when certain data from laboratory tests are available.

STABILITY OF EMBANKMENT FOUNDATIONS

Experiences gained in applying the theory of soil mechanics to the Passamaquoddy Power Project, at Eastport, Me., is contained in a paper entitled "Stability of Embankment Foundations" by B. K. Hough, Jr., Jun. Am. Soc. C.E. Mr. Hough gives a brief description of two methods of stress and settlement analysis for rock and earth-filled dams, calling attention to their advantages and shortcomings and suggesting their extension into a form of analysis developed on the Passamaquoddy Project, by R. M. Haines, Jun. Am. Soc. C.E. In the former methods, the analysts have been concerned mostly with designing embankments so as to prevent overstress of the clay type of foundations. The method here suggested accepts a condition of overstress for economic reasons and offers a means of determining the extent of the resulting settlement as the basis for cost estimates.

SETTLEMENT OF STRUCTURES AND METHODS OF OBSERVATION

The fourth paper of this symposium entitled "Settlement of Structures and Methods of Observation," by Charles Terzaghi, M. Am. Soc. C.E., has special significance for a number of reasons. This paper is offered under the sponsorship of the former Committee on Earths and Foundations, which was authorized by the Board of Direction on October 10, 1927. Ten years of notable research in this relatively new science have terminated in the organization, within the Society, of the new Division of Soil Mechanics and Foundations, the old committee of the Board being merged into the various new committees of the Division. A discussion of Professor Terzaghi's paper, explaining its relation to the work of the Committee on Earths and Foundations follows the paper as published in PROCEEDINGS.

With characteristic thoroughness and keenness of insight, Professor Terzaghi has described methods of observation and settlement observations on several structures in Europe, typical examples being selected to illustrate the behavior of structures on various types of compressible ground. He also gives particular attention to observations of the settlement of buildings on soil foundations and the comparison between the settlement of individual piles under load tests with that of the entire pile foundation. As a guide to experienced judgment, he presents a number of settlement diagrams for given ground conditions and loading and describes some instruments and unique devices for observing such settlement. As a summary to his paper, Professor Terzaghi states, "No method of soil investigation and of settlement computations can be accepted for practical use until the degree of accuracy of the result has been determined by experiment. Such experience can be secured only by reliable and adequate settlement observation. Therefore, the first and the most urgent task in the establishment of a science of soil mechanics consists in standardizing the procedure for making settlement observations."

Special Issue for Student Chapter Members

A YEAR AGO, the September issue of CIVIL ENGINEERING was designed to appeal to the younger engineers, typified by civil engineering students. For this purpose, a special attempt was made to secure articles, comments, and reports that would interest these younger men and answer their daily problems. Furthermore, provision was made to ensure that each member of a Society Student Chapter received a copy of that issue.

During the current autumn a similar plan is in prospect but with some notable changes. In accordance with the recommendations of the Society's Committee on Student Chapters, the Committee on Publications has directed that a special attempt be made along the same general lines as last year. For special reasons, neither the September nor the October issue is a convenient one for such use and therefore the November number has been selected.

It is planned that each member in good standing of a Student Chapter will have the privilege of requesting a complimentary copy of that issue. A number of articles of particular appeal have already been selected. In addition, numerous reports from Student Chapters will be reserved for the November number. It is hoped and expected that the students will find the same interest, and gain the same advantages, as have been reported as a result of the similar arrangement a year ago.

News of Local Sections

INDIANA SECTION

On July 30 the Indiana Section held its summer meeting at the surveying camp of Purdue University, near Lafayette, Ind. The students and members of the faculty at the camp, which was then in session, acted as hosts. The afternoon was spent in inspecting the work and facilities of the camp, and in trying out the athletic equipment. Dinner, which was in the usual camp style, was followed by a business meeting. A memorial resolution on the recent death of Charles Brossman, president of the Section, was presented and adopted. Then several speakers were heard. These included David Ross, president of the Board of Trustees of Purdue University; E. C. Elliott, president of the university; A. A. Potter, dean of the engineering schools; and M. R. Keefe, chief engineer of the Indiana State Highway Commission. In addition to the students, there were 23 present.

MILWAUKEE SECTION

Members of the Milwaukee Section held a dinner meeting at the City Club on June 10. Several business matters were discussed after dinner, and F. W. Ullius was appointed Section delegate to the Local Sections' Conference, at Ann Arbor, Mich., on July 20. The speaker of the evening—C. U. Smith, harbor terminal director at Milwaukee—was then introduced. Mr. Smith traced the history and development of the harbor, reviewing federal and state legislation for the improvement of the harbor and describing the engineering projects that have been constructed in the past ten years.

NEW MEXICO SECTION

On May 22 the New Mexico Section held a meeting at Conchas Dam. The program for the meeting, which was arranged by Hans Kramer, captain, Corps of Engineers, U. S. Army, included an inspection of the town, plant, and construction operations. A paper on the design features of the dam increased interest in the project. This was read by J. B. Alexander, an engineer in the U. S. Engineer Office at Conchas Dam. The group making the trip is shown in the accompanying photograph.

Members of the New Mexico Section Visit Conchas Dam

SACRAMENTO SECTION

Despite the vacation season, attendance was good at the weekly luncheon meetings held by the Sacramento Section during July. At the meeting which took place on July 6, the entertainment committee established the plan of having one of the Juniors of the Section give a short talk at each meeting on some subject in which he is interested or some work on which he is employed. The speaker at this session was J. E. Buchanan, research engineer for the Asphalt Institute. His talk on "Modern Asphalt Highway Construction" was followed by four reels of motion pictures showing highway construction scenes in California. On July 13 a talk was given by Max Bookman, office engineer for the State-Wide Planning Survey, whose subject was "Field Methods of the Highway Planning Survey." The meeting of July 20 was attended by 33 members and guests, who heard an interesting discussion of grade-separation crossings in California. This was given by Glenn L. Enke, associate bridge designing engineer for the state. At the final meeting of the month Alexander Russel spoke on the sewer systems of Sacramento.

SEATTLE SECTION

The last regular meeting of the Seattle Section before the summer recess took place on June 28. During the business session the members voted to establish a Structural Division of the Seattle Section. The purpose of this group is as follows: (1) To assist and encourage the study of the mechanics of structures and structural materials; (2) to provide a convenient means of considering advances and changes in structural theory, practice, and specifications; and (3) to study ideas, problems, and methods submitted in original papers by participants, for mutual instruction, discussion, and criticism. The technical program consisted of a talk by Ben E. Torpen, senior engineer, Corps of Engineers, U. S. Army, who has been in direct charge of construction at Bonneville Dam. Mr. Torpen spoke on the work at Bonneville, illustrating his talk with excellent slides.

At a recent joint meeting of the Seattle Section and the University of Washington Student Chapter, a prize for the best paper presented by one of Student Chapter members was awarded. On this occasion the guest of honor was Walter E. Jessup, Field Secretary of the Society, who spoke on Student Chapter matters. Later Mr. Jessup accompanied the Student Chapter and some of the officers of the Section on an inspection trip to the Skagit River power project.

Federal Department of Public Works

For many years the question of government reorganization has been very actively discussed not only by engineers but by the general public. Simplification of the federal set-up in so far as it concerns duplication of engineering functions and activities has been presented periodically to the profession during the past two decades.

One of the solutions suggested is the creation of a Department of Public Works, to which many of the engineering features now comprised in various of the present government departments might be allocated. Sponsorship of a number of plans has been evident in Congress and on the part of the President as well as of his predecessor.

Cognizant of the activities that are now current, the Board of Direction at its Ann Arbor meeting approved the following resolution:

"*Resolved:* That American Engineering Council be requested to concern itself actively in the enactment of suitable legislation designed to create a Federal Department of Public Works, as proposed by the President of the United States, with definite provision for excluding the Army Engineers and their river and harbor work from this department.

"*Resolved:* That the Construction League of the United States be advised of this action and that its cooperation with American Engineering Council in this movement be requested, and be it

"*Further resolved:* That Past-President Alonzo J. Hammond, as Vice-President of the American Engineering Council, be requested to advise the Board of Direction of the American Society of Civil Engineers from time to time as to progress made in the fulfillment of the mission hereby imposed upon it."

ITEMS OF INTEREST

Engineering Events in Brief

CIVIL ENGINEERING for October

OVER A DOZEN interesting papers, delivered at the Annual Convention of the Society in Detroit, Mich., July 21–24, 1937, are scheduled to be abstracted or summarized in the October issue of CIVIL ENGINEERING. These papers cover such topics as the trend of modern highway transportation, express highways, traffic on the Great Lakes, planning subsurface utilities for city streets, roadside sanitation problems, and the proposed Mackinac Straits Bridge.

The treatment to be accorded each paper will be as complete as space limitations will permit. It is possible that some will be eligible for publication in full in PROCEEDINGS at a later date, and in such cases comparatively brief notice will be given in CIVIL ENGINEERING. The disposition of each will be determined through study by the Committee on Publications, and in both publications an effort will be made to convey to all members some measure of the inspiration of the Annual Convention.

Roads Convention in Canada

THE CANADIAN Good Roads Association announces its twenty-third annual convention, to be held at St. Andrews-by-the-Sea, N.B., September 7, 8, and 9. A number of engineers from the United States will participate. The program includes discussions of drainage, gravel road consolidation, highway design trends, and traffic control. Additional information can be obtained from G. A. McNamee, Secretary-Treasurer, New Birks Building, Montreal.

Wise and Otherwise

DURING his summer vacation down on the farm, Professor Abercrombie helped the farmer with his haying. As a load was being hauled from the field at a rate of 4 mph, the Professor observed an insect crawling round and round one of the wheels on the edge of the rim at a rate of 11 in. per sec. As it reached a point opposite the top of the wheel it could easily descry the barn, but if the insect did in fact note this pleasing rural scene its speed did not vary in the slightest. At this surpassing moment in the insect's career, how fast was it nearing the barn?

In August's problem Professor Abercrombie found himself able to express certain world problems in equivalent mathematical terms and to reduce the entire matter to the determination of two unequal quantities such that the square of the first should be equal to the second and the square of the second equal to the first. The question was to find these quantities and to explain how their character brought peace to the Professor's soul.

If the quantities referred to are x and y, then from the conditions of the problem, $x^2 = y$, $y^2 = x$, $x^4 = y^2$, and $x^3 = 1$. Factoring, $(x - 1)(x^2 + x + 1) = 0$. If the factor $x - 1$ is set equal to zero, then $x = 1$ and $y = 1$. But since the quantities must be unequal, we must set $x^2 + x + 1 = 0$, from which, $x = {}^1/_2(-1 + \sqrt{-3})$ and $y = {}^1/_2(-1 - \sqrt{-3})$. Each of these unequal quantities is equal to the square of the other.

Peace descended on the Professor, explains Harold C. Fiske, M. Am. Soc. C.E., author of the problem, because these quantities (and hence the world problems which they represent) are not real but imaginary.

Suggestions for other problems for Professor Abercrombie's column, accompanied by solutions, may be addressed to the editor. Solutions should preferably be sent in separate enclosed envelopes.

A Memorial Tower of Structural Steel

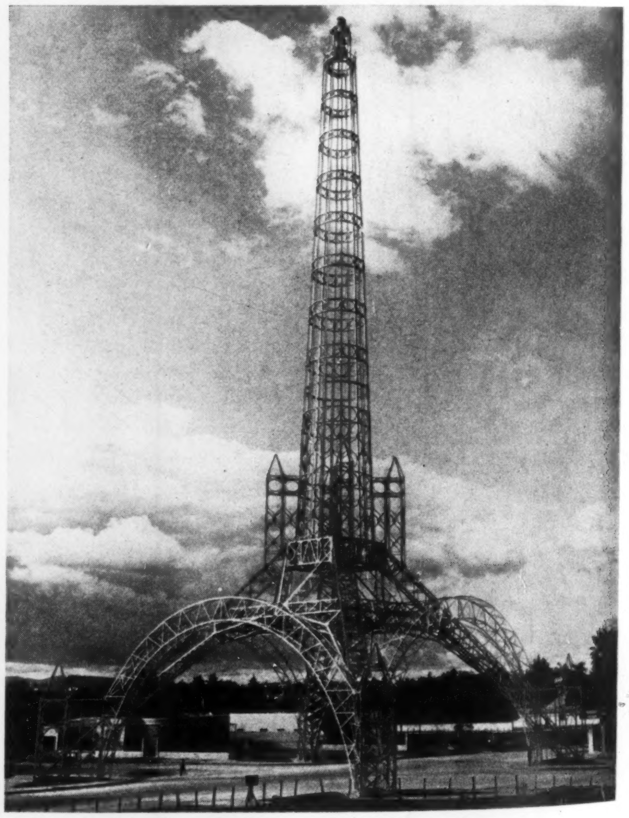
AN ENGINEERING material usually thought of as purely utilitarian has been given architectural beauty as well in the structure shown in the accompanying illustration. This unique tower of structural steel, galvanized to shining whiteness, is an outstanding feature of the sky line of Guatemala City, Guatemala. It was constructed as a memorial to a former president, Justo Rufino Barrios, and was dedicated on July 19, 1935, the one-hundredth anniversary of his birth.

The memorial stands in a marvelous natural setting, with skyscraping, sharp-pointed volcanoes in the near distance. The picture conveys only in part the beauty of the lofty shaft, whose beacon light of blue and white is visible for miles.

Just below the aerial beacon at the top is a solemn-toned memorial bell, a gift from the government of Belgium. The base of the central tower rests upon four graceful arches, which span two intersecting boulevards in a ward of the capital city given over to attractive homes and park-like thoroughfares. On each of the four corners is a battery of flood lights, whose illumination at night brings the tower's silvery brightness into brilliant contrast with the encircling dark.

The tower was fabricated and erected by the U. S. Steel Products Company of New York. George E. Howe, M. Am. Soc. C.E., who contributed the photograph and description, was employed as a consultant on the foundation construction.

Engineering philatelists will be interested to know that this memorial has been reproduced on a new (1937) Guatemalan one-centavo stamp.



Legrand and Co., Guatemala City

THIS 246-FT TOWER IS SUPPORTED BY ARCHES 82 FT IN SPAN

A Page from the History of Robert Fulton's Steamboat

An interesting letter relating to the history of steam navigation has been brought to the attention of Civil Engineering by a member of the Headquarters staff. It is one of a series of letters exchanged in 1804 between Boulton, Watt and Company, of Soho, England (now a part of London), and Robert Fulton, and refers to details of the engine later installed in "The Steamboat," which made its famous first trip up the East River, New York, on August 9, 1807.

Fulton had just returned to England from France, where he had been attempting "to promote the invention of submarine navigation" and where he had demonstrated his first steamboat with considerable success. He was now laying plans for another boat, to be built in the United States, and had engaged the firm of Boulton and Watt to build the engine. The letter reproduced here is a reply to instructions he had given on details of the construction. It reads:

Soho, 25th July 1804.

Robert Fulton, Esq. London.

Sir,—We have your favour of the 20th and shall accordingly make the Air pump its bucket and clack of brass and its rod of Copper. The condenser will do very well of Iron and we should propose to execute it in the manner represented in the annexed sketch which is sent for your approbation previous to our commencing the execution. The Air pump you will see is placed in the Condenser, which is a construction we have sometimes practised; the mouth through which the water and air are discharged, is drawn towards one side but it may be placed in any direction you wish it to have. We recommend that the Cylinder should be placed on a solid block of stone or wood rather than on the edge of this Casting which may be of less dimensions than you had sketched.

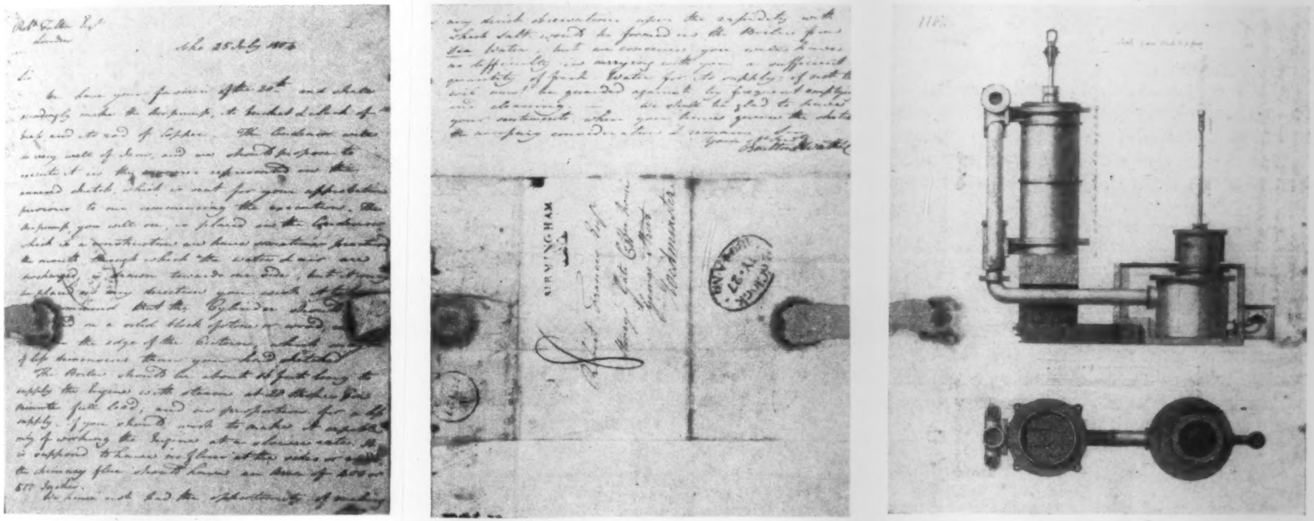
The Boiler should be about 16 feet long to supply the Engine with steam at 20 strokes per minute full load; and in proportion for a less supply, if you should wish to make it capable of working the Engine at a slower rate. It is supposed to have no flues at the sides or ends. The Chimney flue should have an Area of 400 or 500 inches.

We have not had the opportunity of making any direct observations upon the rapidity with which salt would be formed in the Boiler from Sea Water, but we conceive you will have no difficulty in carrying with you a sufficient quantity of fresh water for its supply; if not the evil must be guarded against by frequent emptying and cleaning. We shall be glad to have your sentiments when you have given the sketch the necessary consideration and remain,

Sir, Your obt. Servts,
Boulton, Watt & Co.

The "annexed sketch" was done in colors. It shows the air pump and condenser vertical and the cylinder on a block of stone 16 in. thick.

It will be noted that the letter was self-enclosed—that is, there was no envelope. Hence the address and postmarks on the second page. The blemishes caused by the seal are also visible. Incidentally, the name "Robert Francis," appearing in the address, was assumed by Fulton for diplomatic reasons during his stay in England.



A Letter to Robert Fulton from Boulton, Watt and Company, Dated July 25, 1804

NEWS OF ENGINEERS

Personal Items About Society Members

Clark Kittrell has been made district engineer in charge of the Fort Peck Dam project in Montana. He succeeds Lt. Col. Thomas B. Larkin, who will enter the U. S. War College in Washington, D.C.

Nathan H. Jones, formerly field superintendent for the M. W. Kellogg Company, of New York City, is now with the J. G. White Engineering Corporation, with headquarters in the same city.

Joseph Schulcz has resigned as junior engineer in the U. S. Engineer Office at Philadelphia, Pa., to become structural draftsman for W. Herbert Gibson, consulting engineer of Philadelphia.

Harry Parker Hammond, professor of civil engineering at the Polytechnic Institute of Brooklyn, has been appointed dean of the school of engineering at Pennsylvania State College. He succeeds Robert L. Sackett, who is retiring after twenty-two years of service.

Percy H. Bliss, who is with the Corps of Engineers, U. S. Army, has been transferred from Memphis, Tenn., to the Little Rock (Ark.) District Office, where he is junior hydraulic engineer.

Robert B. Van Horn, associate professor of civil engineering at the University of Washington, has been appointed head of the civil engineering department.

William Whitfield Lewis has resigned as instructor in civil engineering at Duke University to become a designer and estimator for the Bethlehem Steel Company, Bethlehem, Pa.

B. W. Boguslavsky, who has been working toward his doctor's degree at Massachusetts Institute of Technology, is at present employed in the Washington State Highway Department, with headquarters at Olympia, Wash.

Frank W. Barnes is now construction manager for the Merritt-Chapman and

Scott Corporation, of New York City. He was formerly with Parsons, Klapp, Brinckerhoff and Douglas, of the same city.

Joseph P. Reinheimer, since 1919 assistant city engineer of Springfield, Ohio, has taken a position with the Ohio Edison Company as assistant resident engineer on the construction of an addition to the Mad River power plant.

Harold G. Sours has entered the employ of the Truscon Steel Company in the capacity of promotion engineer of highway products. Previously he was county engineer of Summit County, Ohio.

K. C. Wright is now manager of the industrial equipment division of the Lang Company in Salt Lake City, Utah. He was formerly chief engineer of the Utah State Road Commission.

R. L. A. Martin has resigned as inspector in the U. S. Engineer Office at Pittsburgh, Pa., to become a junior engineer with the Federal Power Commission, in Washington, D.C.

Joseph S. Gatewood, an associate engineer in the U. S. Geological Survey, has been transferred from Tucson, Ariz., to Washington, D.C., where he will be for some time.

John A. Johnston has been promoted from the post of district engineer for the Massachusetts Department of Public Works to that of associate civil engineer in the same organization.

R. E. Coughlin, Captain, Corps of Engineers, U. S. Army, has been assigned to take charge of the Dover area of the Muskingum Watershed Conservancy District.

William H. Trinkhaus, for the past two years acting chief engineer of the Sanitary District of Chicago, has been made chief engineer of the District.

Lee H. Johnson has been appointed dean of the engineering school at the University of Mississippi. He was formerly in the U. S. Engineer Office at Mobile, Ala.

William P. Feeley is now chief engineer of the Great Lakes Dredge and Dock Company, with headquarters in Chicago, Ill. Mr. Feeley has been associated with the Buffalo office of this company for almost thirty years.

Edward Silberman, previously an engineer for the Minneapolis Dredging Company, Kansas City, Kans., is now employed as an engineering aide in the General Planning Division of the Tennessee Valley Authority.

John G. Hoad has resigned as acting equipment engineer for the Michigan State Highway Department to accept a position with the Detroit Edison Company, of Detroit, Mich.

Ferdinand N. Menefee, professor of engineering mechanics at the University of Michigan, was awarded the honorary degree of doctor of engineering by Lawrence Institute of Technology during the past commencement season.

John C. Kohl, formerly an instructor in the department of civil engineering at Carnegie Institute of Technology, is now engaged in development work for the central research department of the Pittsburgh Plate Glass Company, Pittsburgh, Pa.

Leslie S. Marshall, civil engineer and surveyor of Hempstead, N.Y., was recently appointed village engineer of Hempstead.

E. P. Arneson has resigned as director of the 10th WPA District in Texas and has resumed his consulting engineering practice in San Antonio, Tex.

Dalton M. Brown, formerly an engineer for the Marcus Contracting Company Inc., of New York City, has entered the employ of Spencer, White, and Prentis, of the same city.

A. Judson Warlow is now chief engineer for the General State (Pennsylvania) Authority, with headquarters at Harrisburg, Pa. Previously Mr. Warlow was chief construction engineer in the Department of Property and Supplies, Commonwealth of Pennsylvania.

Wilfred M. Hall left the Tennessee Valley Authority upon completion of the Wheeler Dam and power plant to become connected with the Puerto Rico Reconstruction Administration, with headquarters at Ponce, Puerto Rico, where he is in charge of the design and construction of hydroelectric projects.

Gibb Gilchrist has been appointed dean of the Agricultural and Mechanical College of Texas and will assume his new duties at the beginning of the fall term. He was formerly state highway engineer of Texas.

William Mumsey Wilson, previously assistant state engineer inspector for the PWA at Fort Worth, Tex., has established a structural engineering practice at Austin, Tex.

Henning O. Christiani was recently appointed consulting bridge engineer, New Haven, Conn. Formerly Mr. Christiani was an engineer for Madigan-Hyland, of New York City.

Augustus Rowley Archer, previously general superintendent of construction for the New Jersey Reformatory at Annandale, N.J., has opened an office for the practice of designing and consulting engineering at Somerville, N.J.

Jo Buck Jones is now state field engineer for the WPA at San Antonio, Tex. He was formerly assistant director of WPA District 5 at Palestine, Tex.

Alfred E. Roche has recently been installed as president of the New York State Society of Professional Engineers. Mr. Roche is engineer for 21 counties of New York State for WPA projects.

Irving G. Grundel is now with the San Luis Mines Company at Lima, Peru, where he is in charge of the design and construction of an aerial wire rope tramway. Before going to Peru, Mr. Grundel was designing engineer for the Holly Sugar Corporation at Alvarado, Calif.

DECEASED

Louis Schumann Bruner (Assoc. M. '15) of Philadelphia, Pa., died in that city on July 25, 1937. Mr. Bruner was born in Philadelphia on December 26, 1883, and graduated from the University of Pennsylvania in 1905. From 1907 to 1911 he was an instructor in civil engineering at the University of Pennsylvania; from 1911 to 1915, with the Canada Cement Company, Ltd.; from 1915 to 1917, manager of the Dallas branch of the Portland Cement Association; from 1919 to 1921, sales engineer for the Lakewood Engineering Company (Cleveland); from 1922 to 1925, with Light, Hollister, and Ferguson, consulting engineers of Philadelphia; from 1925 to 1928, statistician and comptroller for the National Freight and Delivery Company; and from 1929 to 1932, sales and field engineer for the Lone Star Cement Company, Philadelphia. During the war Mr. Bruner served as first-lieutenant and, later, as captain of the 23d Engineers, U. S. Army.

Frank David Chase (M. '12) president of Frank D. Chase, Inc., of Chicago, Ill., died at his home in Evanston, Ill., on July 23, 1937. Mr. Chase, who was 60, was born in Riverside, Ill., and educated at the Massachusetts Institute of Technology. For several years he was architect for the Illinois Central Railroad and later served in the same capacity for the Western Electric Company. In 1913 he became president of Frank D. Chase, Inc., an engineering and architectural firm specializing in the design of industrial plants. He designed large newspaper plants in several Middle Western cities as well as many notable building projects in Chicago.

Charles Henry Eglee (Affiliate '07) retired engineer, died at Cohasset, Mass., on July 4, 1937, at the age of 79. Mr. Eglee, who was born in Flushing, N.Y., began construction work with Henry Lewis, water-works contractor, and in 1883 was admitted to the firm. From 1885 to 1903 he had his own firm, which was engaged principally in the design and building of various water works in New England. Later Mr. Eglee was general manager of the Ambursen Construction Company, of Boston; manager of the dam and water power department of the Aberthaw Construction Company; and industrial counselor for the Massachusetts Leather Association. He retired from the latter position in 1936.

Ross Elroy **Hamilton** (Assoc. M. '14) an engineer of Coshocton, Ohio, died there on July 24, 1937. Mr. Hamilton was born in Coshocton County on September 1, 1878, and graduated from Ohio State University in 1903. From 1903 to 1909 he was engaged in railroad location and construction; from 1909 to 1913 he was county surveyor for Coshocton County; from 1913 to 1916, division engineer on the Ohio and Erie Canal; from 1917 to 1921, county surveyor for Coshocton County; and from 1923 to 1935, resident engineer for the Ohio State Highway Department. Recently he established a private engineering practice.

Solon Herzig (M. '29) resident engineer inspector for the PWA, Ocoee, Fla., died on July 28, 1937. Mr. Herzig, who was 52, was born in New York City. Following his graduation from the Polytechnic Institute of Brooklyn in 1910, he was, successively, in the engineering department of Pierson and Goodrich; assistant to E. P. Goodrich; and civil engineer for the Montana Power Company, Butte, Mont. During the war he served with the 25th Engineers in France. From 1919 to 1923 he was president of Tilden and Herzig, Inc., engineers and contractors; from 1923 to 1925, president of Herzig and Solomon, Inc.; and from 1925 to 1926, general manager and engineer in the structural steel department of the J. Cutler Iron Works, Inc. In the latter year Mr. Herzig established a structural engineering practice in New York City, which he maintained until recently.

Alexander Rice McKim (M. '98) retired consulting engineer of Marblehead, Mass., died there on July 28, 1937, at the age of 74. Mr. McKim was born in Boston and graduated from Massachusetts Institute of Technology in 1886. In 1896, after early experience in bridge and railroad work, he became consulting structural engineer for New York City and New York State Inspector of Docks and Dams, remaining in these positions until 1911. From 1911 until 1921 he was in the New York State Conservation Commission, and from 1921 until his retirement in 1927 he was in the State Engineer's Department.

Robert Speirs Saunders (Assoc. M. '20) section engineer for the Board of Transportation, New York, N.Y., died at his home in Stapleton, N.Y., on July 26, 1937. He was 53. Mr. Saunders was born in St. Louis, Mo., and educated at Cooper Union. From 1912 to 1913 he was assistant engineer for the New York City Board of Water Supply; from 1913 to 1920, junior engineer for the Public Service Commission; and from 1921 to 1924, assistant engineer for the Transit Commission. In 1924 he began his association with the Board of Transportation. During the war Mr. Saunders commanded a squadron of submarines on hazardous overseas convoy duty.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

William Lee Selmer (Assoc. M. '15) chief of the Division of Railroad Engineering of the New York City Transit Commission, died in that city on July 11, 1937. Mr. Selmer, who was 54, was born in Boston, Mass., and educated at Cooper Institute. Beginning in 1907, he was for many years connected with the New York City Public Service Commission, serving successively as principal assistant engineer, assistant engineer, and civil engineer. Several years ago be became acting chief of the Bureau of Railroad Inspection of the Transit Commission, and was recently made chief of the Division of Railroad Engineering. During his long connection with the city, Mr. Selmer supervised all the grade-crossing elimination work within the city limits and the structural work on the elevated lines.

Edward Everett Stetson (M. '23) assistant to the chief engineer of the Pennsylvania Railroad, Chicago, Ill., died on July 13, 1937. Mr. Stetson was born at Mattapoisett, Mass., October 8, 1882, and graduated from Massachusetts Institute of Technology in 1904. From 1905 to 1919 he was connected with the Pennsylvania Railroad in a variety of capacities. From 1919 to 1923 he was engineer of construction for the Chicago Union Station Company, and from 1923 to 1926, principal assistant engineer for the same organization. In the latter year he reentered the service of the Pennsylvania Railroad, becoming assistant to the chief engineer.

Winter Lincoln Wilson (M. '01) professor emeritus of railroad engineering at Lehigh University, died in a hospital at Sandy Spring, Md., on July 15, 1937. He was 71. Professor Wilson was born at Elkton, Md. and graduated from Lehigh University in 1888. In 1897, following several years with the Pennsylvania Railroad, he went to Lehigh as an instructor in civil engineering. He was assistant professor of civil engineering at Tulane University from 1901 to 1904, returning to Lehigh in the same capacity in the latter year. In 1907 he was appointed to the chair of the J. T. Stuart professorship of railroad engineering, remaining in that position until 1935 when illness forced his retirement.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From July 10 to August 9, 1937, Inclusive

Additions to Membership

Adamowitz, Michael (Jun. '37), 21 Eldridge St., New York, N.Y.

Anglade, Carlos (Assoc. M. '37), Marron á Pelota 8, Caracas, Venezuela.

Bailey, Ellsworth Barr (Assoc. M. '37), Designer-Draftsman, Eng. Dept., Shell Oil Co. Refinery, Martinez (Res., 2402 East St., Concord), Calif.

Bell, James Douglas (Assoc. M. '37), Insp., U. S. Engrs., Bonneville, Ore.

Bennett, Chilton Gordon (Assoc. M. '37), Asst. Engr., National Park Service, Braniff Bldg., Oklahoma City, Okla.

Benson, Joseph Louis (Assoc. M. '37), Analyst, Associate Rate Investigator, and Asst. Engr., Federal Power Comm., 10 Forsyth St., Atlanta, Ga.

Best, Walter Eugene (Jun. '37), Asst. Engr., % U. S. Engr. Office, Vicksburg, Miss.

Bird, Charles Franklin (Jun. '37), With Shoecraft, Drury & McNamee (Res., 1309 Elder Boulevard), Ann Arbor, Mich.

Blohm, Arthur William Paul (Assoc. M. '37), Asst. San. Engr., State Dept. of Health (Res., 2206 Walbrook Ave.), Baltimore, Md.

Boriss, Marion Elmo (Assoc. M. '37), Acting San. Engr., Jefferson County San. Dept., 216 Court House (Res., 1019 Oxmoor Road), Birmingham, Ala.

Brown, Roy Tilson (Assoc. M. '36), Asst. Prof., Dept. of Civ. Eng., Univ. of Tennessee, 22 Carrick Hall, Univ. of Tennessee, Knoxville. Tenn.

Bruner, Francis Daniel Pastorius (Assoc. M. '37), Asst. Civ. Engr., R A; Senior Engr. Foreman, National Park Service, Richmond (Res., 1763 Berkeley Ave., Petersburg), Va.

Butler, Weldon Collins (Jun. '37), 409 West Saulnier, Houston, Tex.

CAMERON, HOWARD JAMES (Jun. '37), Asst. Civ. Engr., U. S. Dept. of Interior, National Park Service, Cave City, Ky.

CARDILE, FRANK (Jun. '37), Chf. of Party, WPA, Dept. of Hospitals (Res., 1700 Washington Ave.), New York, N.Y.

CASANUEVA, RUPERTO (Jun. '37), Calle Rosales 1677, Santiago, Chile.

CLARK, JOHN JAMES (Assoc. M. '37), Senior Civ. Engr., Water Div., City of St. Louis (Res., 5807 Enright Ave.), St. Louis, Mo.

CORNEY, WILLIAM HARRY VICTOR (Assoc. M. '37), Box 1183 K, Gen. Post Office, Adelaide, South Australia.

CORRADI, PETER (Jun. '37), Senior Draftsman, War Dept., Engr. Corps, U. S. A., 80 Broad St. (Res., 175 West 188th St.), New York, N.Y.

DAVIES, CLARENCE WILLIAM EDWARD (Jun. '37), Structural Draftsman, Gen. Electric Co. (Res., 834 Lincoln Ave.), Schenectady, N.Y.

FARLEY, RICHARD WARREN (Assoc. M. '37), Junior Engr., U. S. R A, Huntingdon (Res. 51 East Market St., Mount Union), Pa.

FORSHAY, RAYMOND LEROY (Jun. '37), Junior Structural Engr., TVA, 711 Union Bldg. (Res., 2007 Coker Ave.), Knoxville, Tenn.

FOSTER, WILLIAM SOUTHMAYD (Jun. '37), Paving Insp., State Highway Comm. (Res., 1107 Duff Ave.), Ames, Iowa.

FOX, LOUIS EDGAR (Jun. '37), Project Engr., State Bureau of Highways, Ashton, Idaho.

GREENBAUM, ERVIN (Jun. '37), Junior Engr., R A, Suburban Resettlement Div., West Allis, Wis. (Res., 4021 Sturtevant St., Detroit, Mich.)

GREGG, DUNCAN SMITH (Jun. '37), Engr. for W. A. Bechtel Co. and Columbia Constr. Co., Bonneville, Ore.

GUARDIA, CARLOS ALBERTO (Assoc. M. '37), Ingeniero Sanitario, Dept. de Sanidad, Box 1175, Caracas, Venezuela.

GUTTERIDGE, ALAN GORDON (M. '37), Cons. Engr., 440 Little Collins St., Melbourne, Victoria, Australia.

HASS, RAYMOND CHESTER (Jun. '37), Junior Engr., Minneapolis-St. Paul San. Dist., Box 3598, St. Paul, Minn.

HAVEN, ANTHONY FRANKLIN (Assoc. M. '37), Structural Engr., Commonwealth & Southern Corporation, 814 Third St., Jackson, Mich.

HAYES, HOWARD MAXWELL (Jun. '37), Asst. Eng. Aide, TVA, Scottsboro, Ala.

HEDRICK, TERRENCE OTIS (Assoc. M. '37), Asst. Bridge Designer, State Highway Comm. (Res., 1267 Wayne Ave.), Topeka, Kans.

HOLLISTER, LEONARD COCHRAN (Assoc. M. '37), Associate and Senior Bridge Engr., State Bridge Dept. (Res., 326 Santa Ynez Way), Sacramento, Calif.

HOOKMAN, ROBERT ERNEST (Assoc. M. '37), Designer, State Highway Comm. (Res., 1307 Tyler St.), Topeka, Kans.

HUTCHINSON, HOMER BRINSON, JR. (Jun. '37), Insp., TVA, Box 14, New Hope, Ala.

JONES, FRANCIS ROSSER (Assoc. M. '37), Associate Engr., U. S. Engr. Office, 925 New Federal Bldg., Pittsburgh, Pa.

KESSLER, LEWIS HANFORD (Assoc. M. '37), Asst. Prof., Hydr. and San. Eng., Univ. of Wisconsin (Res., 30 Virginia Terrace), Madison, Wis.

LENDO, ALEXANDER CHESTER (Jun. '37), Asst., Dept. of Civ. Eng., Univ. of Maine, Orono, Me. (Res., Otter River, Mass.)

MATTHIAS, FRANKLIN THOMPSON (Assoc. M. '37), Asst. Civ. Engr., TVA (Res., 214 Rennoc Rd.), Fountain City, Tenn.

MEIKLEJOHN, ROBERT, JR. (Jun. '37), Asst. to Roadmaster, G. N. Ry., M. of W. Dept. (Res., 1402 Lewis Boulevard), Grand Forks, N.Dak.

MOODY, TED MILLARD (Jun. '37), Junior Asst. Engr., International Boundary Comm. Flood Control, Constr. Div., McAllen, Tex.

NIXON, DANIEL DECATUR (Jun. '37), Instrumentman, State Highway Dept. (Res., 1225 Second St.), Corpus Christi, Tex.

OLMSTEAD, ERI (Assoc. M. '37), Res. Engr. Insp., PWA, 1250 National Bank Bldg., Detroit, Mich.

OSMUNDSON, VERNE N. (Jun. '37), Junior Constr. Foreman, U. S. Forest Service, Chippewa National Forest, Rabideau Camp F-50, Blackduck, Minn.

PATTERSON, WILLIAM LAWRENCE (Assoc. M. '37), Designer, Black & Veatch (Res., R. R. No. 2, Woodhaven Add.), Kansas City, Mo.

PEPE, SALVATORE ERNEST (Jun. '37), Asst. Engr., U. S. Engr. Office, Custom House (Res., 18 Channing Rd., Watertown), Boston, Mass.

PHILLIPS, ROBERT MARCHANT, JR. (Jun. '37), 1206 West 59th St., Los Angeles, Calif.

RAMIREZ DE ARELLANO, FRANK (Jun. '37), Asst. Engr., Carlos del Valle Zeno, Box 485, San Juan, Puerto Rico.

RICKS, PAUL CARDON (Assoc. M. '37), Asst. to Engr. Appraiser, Federal Land Bank of Berkeley, Oakland (Res., 1504 Masonic Ave., San Francisco), Calif.

SHAW, GEORGE REED (Jun. '37), Instr., Dept. of Surveying and Road Eng., Rensselaer Polytechnic Inst. (Res., 2218 Sixteenth St.), Troy, N.Y.

SHERMAN, DANA CARROLL (Jun. '36), 27 Pleasant St., Mansfield, Mass.

SWANSON, THEODORE ANDREW (Jun. '37), 501 Olympic Pl., Seattle, Wash.

THOM, GEORGE MCLENNAN (Jun. '37), Junior Engr., Orange County Highway Dept., 27 Prospect St., Newburgh, N.Y.

THOMPSON, WALTER EDWIN (Assoc. M. '37), 280 Henry St., Brooklyn, N.Y.

THORSON, ROBERT DEAN (Assoc. M. '37), Associate Bridge Engr., State Div. of Highways, Dept. of Public Works, Bridge Dept. (Res., 2286 West 23rd St.), Los Angeles, Calif.

TRACY, JOSEPH EDWARD (Assoc. M. '37), Engr., The Pitometer Co., 75 State St., Albany, N.Y.

TRIVELY, ILO ALLELY (Jun. '37), Instr., Univ. of Nebraska (Res., 2311 Ryons St.), Lincoln, Nebr.

WALKER, DOUGLAS CRESSY (Assoc. M. '37), Res. Engr. on Constr., Met. Water Dist. of Southern California, Colorado River Aqueduct, Box 426, Indio, Calif.

WEINBERG, MORRIS (Jun. '37), 36 Market St., New York, N.Y.

WESTBROOK, JAMES AUGUSTUS (Jun. '37), 1610 Jarvis St., Raleigh, N.C.

WORSHAM, WALTER BOATMAN (Assoc. M. '37), Asst. Engr. of Materials, State Div. of Highways, Dept. of Public Works and Bldgs. (Res., 1912 South 5th St.), Springfield, Ill.

ZIPPRODT, ROY RICHARD (M. '37), Associate Prof., Civ. Eng., Columbia Univ., 423 Eng. Bldg., Columbia Univ., New York, N.Y.

MEMBERSHIP TRANSFERS

ANGLE, JAMES MACFARLANE (Assoc. M. '21; M. '37), Senior Highway Bridge Engr., U. S. Bureau of Public Roads (Res., 201 Clayton St.), Montgomery, Ala.

BAUER, EDWARD EZRA (Assoc. M. '25; M. '37), Asst. Prof., Civ. Eng., Univ. of Illinois, 204 Materials Testing Laboratory, Univ. of Illinois, Urbana, Ill.

BELL, FRANCIS MURDOCH (Jun. '26; Assoc. M. '37), Dist. Engr., U. S. Geological Survey, Georgia School of Technology, Atlanta, Ga.

COLLIER, ERWIN TILDEN (Jun. '29; Assoc. M. '37), Project Engr., State Road Dept., Box 649, Orlando, Fla.

COOK, WARREN STEWART (Jun. '30; Assoc. M. '37), Bridge Designer, U. P. R. R. (Res., 2217 Ogden St.), Omaha, Nebr.

EVANS, JOHN MARSHALL (Jun. '21; Assoc. M. '24; M. '37), Head of Ciy. Eng. Div., Eng. Dept., Standard Oil Co. of California, 225 Bush St., San Francisco, Calif.

FLYNN, JOHN KELLY (Jun. '30; Assoc. M. '37), Senior Eng. Aid, State Dept. of Public Works 80 Centre St., Room 837, New York, N.Y.

FUCIK, JOHN FRANK, JR. (Assoc. M. '24; M. '37), Asst. Engr., Board of Local Impvts., City of Chicago, 207 City Hall (Res., 2557 Hollywood Ave.), Chicago, Ill.

GISIGER, PAUL EDWARD (Assoc. M. '24; M. '37), Structural Engr., Pennsylvania Water & Power Co. and Safe Harbor Water Power Corporation, 1611 Lexington Bldg., Baltimore, Md.

GULICK, HAROLD VAN DYKE (Assoc. M. '31 M. '37), Engr. in Chg. of Constr. Office, Am. Locomotive Co. (Res., 1762 Lenox Rd.), Schenectady, N.Y.

HARLESS, CHARLES MALCOLM (Jun. '26; Assoc. M. '37), Asst. to Chf. Engr., Port Neches Works, The Texas Co., Port Neches, Tex.

HOLMES, PAUL MORDAUNT (Assoc. M. '28 M. '37), Designing Engr., Div. of Eng. and Constr., City of Columbus (Res., 1106 South 22d St.), Columbus, Ohio

LINDBLOM, CLIFFORD THEODORE (Jun. '30 Assoc. M. '37), Associate Engr., U. S. Engr. Office, 702 Federal Bldg., Cincinnati, Ohio.

MUNROE, JAMES EDWARD (Jun. '31; Assoc. M. '37), Engr. and Gen. Supt., James A. Munroe & Sons (Res., 142 North Washington St.), North Attleboro, Mass.

OLSON, LELAND ALFRED (Assoc. M. '30; M. '37), Structural Designer, Bridge Dept., Nickel Plate R. R., Room 936, Terminal Tower Bldg., Cleveland, Ohio.

TOTAL MEMBERSHIP AS OF AUGUST 9, 1937

Members	5,682
Associate Members	6,167
Corporate Members	11,849
Honorary Members	23
Juniors	3,524
Affiliates	85
Fellows	1
Total	15,482

Remley, Norman Williams (Jun. '26; Assoc. M. '37), Designer, State Highway Dept., Highway Bldg., Jefferson City, Mo.

Tingey, Willis Alma (Jun. '34; Assoc. M. '37), Asst. Topographic Engr., U. S. Geological Survey, Box 163, Bowling Green, Mo.

Waldo, Willis Gersham (Assoc. M. '20; M. '37), Cons. Engr., 506 Mills Bldg., 17th and Pennsylvania Ave., N. W., Washington, D.C.

Reinstatements

Cullen, Walter Hamilton, Assoc. M., reinstated June 1, 1937.

Fish, Gilbert Dudley, M., reinstated July 22, 1937.

Gialdini, Gene John, Assoc. M., reinstated July 12, 1937.

Johnston, Roy Nelson, Assoc. M., reinstated July 12, 1937.

Johnston, Walter Wier, M.; reinstated July 12, 1937.

Massey, George Hubard, M., reinstated May 3, 1937.

Stivers, Sherman Harry, M., reinstated June 22, 1937.

Resignations

Elliott, Ben Robert, Jun., resigned July 9, 1937.

Houtman, Gustave Desire, Assoc. M., resigned July 13, 1937.

Jorissen, Andre Laurent, Jun., resigned July 27, 1937.

Smart, Clinton Hayner, Affiliate, resigned July 13, 1937.

Van Wingen, Nico, Jun., resigned July 9, 1937.

Wermecke, Kasper de Nyssen, Assoc. M., resigned July 13, 1937.

Applications for Admission or Transfer

Condensed Records to Facilitate Comment of Members to Board of Direction

September 1, 1937

Number 9

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years*	5 years of important work
Associate Member	Qualified to direct work	27 years	8 years*	1 year
Junior	Qualified for sub-professional work	20 years†	4 years*	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years*	5 years of important work
Fellow	Contributor to the permanent funds of the Society			

* Graduation from an engineering school of recognized reputation is equivalent to 4 years of active practice.

† Membership ceases at age of 33 unless transferred to higher grade.

The fact that applicants refer to certain members does not necessarily mean that such members endorse.

ADMISSIONS

Albertson, John Gilbert, Oradell, N.J. (Age 38.) With Thomas F. Bowe, Cons. Engr., New York City. Refers to A. P. Ackerman, T. F. Bowe, L. L. Langford, S. B. Lilly, M. B. Tark.

Allen, George Wade, Milwaukee, Wis. (Age 21.) Refers to J. H. Cissel, W. C. Sadler.

Allison, Fred Gray, Atlanta, Ga. (Age 53.) Research Engr., Div. of Tests and Investigations, State Highway Board of Georgia. Refers to W. E. Ford, G. L. Fry, B. M. Hogan, K. W. LeFever, I. Van Trump, H. M. Wright, W. W. Zass.

Alwart, Harold John, Chicago, Ill. (Age 22.) Engr., McCracken Constr. Co. Refers to F. J. Converse, R. R. Martel, F. Thomas.

Anderson, Carl Edward, Edgewood, R.I. (Age 23.) Refers to W. R. Benford, L. T. Bohl.

Anderson, Everett Gordon, Fort Riley, Kans. (Age 24.) Refers to H. B. Blodgett, H. S. Carter.

Anderson, Robert Wilson, South Attleboro, Mass. (Age 23.) Refers to W. R. Benford, L. T. Bohl.

Appleget, Harlan Jackson, Buffalo, N.Y. (Age 23.) Refers to A. H. Holt, R. B. Kittredge, B. J. Lambert, C. A. Renshaw.

Baker, James Monroe, McKeesport, Pa. (Age 21.) Refers to C. A. Ellis, R. B. Wiley.

Ballard, John Scott, Montclair, N.J. (Age 21.) With Wallace & Tiernan Co., Inc. Refers to S. B. Lilly, C. U. Powell.

Barnett, Thomas Edward, Brooklyn, N.Y. (Age 21.) With Transit Equipment Co., New York City. Refers to H. P. Hammond, L. F. Rader, E. J. Squire.

Barraza, Louis Julius, San Francisco, Calif. (Age 34.) With California Div. of Highways. Refers to J. Cherno, F. B. Dauchy, T. E. Ferneau, H. G. Gerdes, G. A. Greene, C. V. Kane, L. J. Stephenson.

Benford, Esther Rosalind, Charleston, W.Va. (Age 21.) Refers to R. P. Davis, W. S. Downs.

Bistline, Samuel Eldon, Wilkinsburg, Pa. (Age 23.) Draftsman, Eng. Dept., Dept. of Bridges & Bldgs., Pennsylvania R.R. Co. Refers to F. M. McCullough, C. B. Stanton.

Blackwell, Benjamin Richard, Waterville, Maine. (Age 23.) Refers to H. Bouchard, C. O. Wisler.

Blenderman, William Edward, New York City. (Age 21.) Refers to J. J. Costa, A. V. Sheridan.

Bohac, Frank Joseph, Ft. Dodge, Iowa. (Age 27.) Bldg. Inspector, Industrial Eng. and Constr. Dept., International Harvester Co. Refers to A. A. Chenoweth, E. D. Dake.

Bonner, John Foster, Piedmont, Calif. (Age 23.) Hydrographer, Pacific Gas & Elec. Co., San Francisco, Calif. Refers to A. P. Denton, C. Derleth, Jr., B. A. Etcheverry, S. T. Harding, J. H. Lawrence, L. O. Murphy, O. G. Stanley.

Boothe, Raymond Hudson Ferris, Bishop, Calif. (Age 23.) Senior Eng. Aid, State Dept. of Public Works, Div. of Highways, Dist. IX. Refers to R. R. Martel, W. W. Michael, F. Thomas.

Borg, Joseph Elmer, Ambridge, Pa. (Age 21.) Draftsman, Structural Dept., American Bridge Co. Refers to A. H. Fuller, F. Kerekes, M. C. Miller.

Brammer, Paul Edwin, Hinton, W.Va. (Age 24.) Refers to W. J. Carrel, D. V. Terrell.

BROGUNIER, CHARLES HENRY, Vancouver, Wash. (Age 24.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

BROMILOW, FRANK, Avalon, Pittsburgh, Pa. (Age 21.) Refers to A. Diefendorf, L. C. McCandliss.

BROWN, ARTHUR ORVILLE, Ephrata, Wash. (Age 24.) Refers to W. L. Malony, H. E. Phelps, M. K. Snyder, B. E. Torpen, J. G. Woodburn.

BRUMAGE, ROBERT CASSIL, Laramie, Wyo. (Age, 22.) Refers to R. D. Goodrich, E. K. Nelson, H. T. Person.

BURDIN, HENRY SPRAGUE, JR., Portland, Ore. (Age 22.) Refers to J. R. Griffith, G. W. Holcomb, F. Merryfield, C. A. Mockmore.

BURKE, HARRIS HUXLEY, Albuquerque, N.Mex. (Age 21.) Refers to J. H. Dorroh, F. Healy.

BURKEBILE, FREDERICK VERNON, Everett, Wash. (Age 22.) Refers to G. E. Hawthorn, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

BUSSE, FRANK AUGUSTUS, Maplewood, N.J. (Age 32.) Asst. Instructor, Dept. of Civ. Eng., Newark Coll. of Eng. Refers to H. N. Cummings, C. N. Dunham, C. Gilman, H. Haufley, W. L. LaLonde, Jr., A. P. Richmond, Jr., R. Ridgway.

BUTTERFIELD, GLEN ROBERT, JR., Seattle, Wash. (Age 21.) Refers to G. E. Hawthorn, R. G. Hennes, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

BUTTON, PAUL STUART, Knoxville, Tenn. (Age 28.) Asst. Eng. Aide, TVA. Refers to P. Jones, H. B. Luther, R. W. Renn.

CANNISTRA, STEPHEN ANTHONY, Pittsburgh, Pa. (Age 22.) Refers to A. Diefendorf, L. C. McCandliss.

CARRICK, HARRY HALL, JR., Los Angeles, Calif. (Age 22.) Draftsman, Western Pipe & Steel Co. Refers to R. R. Martel, W. W. Michael, F. Thomas.

CASHMAN, BERNARD DONALD, Burlington, Vt. (Age 21.) Refers to G. F. Eckhard, A. E. Horst, D. W. Overocker.

CEDERGREN, HARRY ROLAND, Seattle, Wash. (Age 26.) Refers to C. W. Harris, R. G. Hennes, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

CHEATHAM, ROBERT ARTHUR, Olympia, Wash. (Age 25.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

CHENOWETH, HARRY HOLT, Seattle, Wash. (Age 23.) Refers to F. B. Farquharson, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

CHESTON, JAMES HUNTER, Knoxville, Tenn. (Age 38.) Senior Specifications Engr., TVA, Knoxville, Tenn. Refers to A. J. Ackerman, J. G. Allen, H. F. Anthony, R. N. Coolidge, F. J. O'Brien, W. G. Stromquist, H. E. Whitney.

CHRISTENSEN, LAWRENCE ALFRED, North Quincy, Mass. (Age 25.) Refers to F. A. Barnes, C. Crandall, S. C. Hollister, J. E. Perry, P. H. Underwood.

CHRISTOFFERSON, LE GRAND, Rock Springs, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

COE, CLEVELAND BEACH, Chattanooga, Tenn. (Age 44.) Asst. Highway Engr., TVA. Refers to J. B. Bradner, E. Harsch, F. E. Junior, J. H. Kimball, P. C. Klyce, J. M. Moreland, R. L. Morrison, E. Scroggie, F. W. Webster.

COLLINS, JOHN GRIFFIN, San Francisco, Calif. (Age 24.) Refers to J. R. Griffith, F. Merryfield, C. A. Mockmore.

CONFORTI, JAMES, JR., New York City. (Age 21.) Refers to L. V. Carpenter, A. Haring, T. Saville, C. T. Schwarze, D. S. Trowbridge.

CONKLING, LEON DEVERE, Bozeman, Mont. (Age 65.) Prof. and Head, Dept. of Civ. Eng., Mont. State Coll. Refers to F. M. Brown, I. C. Crawford, C. S. Heidel, W. A. Lamb, R. S. Stockton, F. E. Thieme, R. H. Willcomb.

COOPER, CARL COLMAN, Seattle, Wash. (Age 21.) Refers to G. E. Hawthorn, A. L. Miller, F. H. Rhodes, Jr., R. G. Tyler.

COULTER, RICHARD GALLAHER, Syracuse, N.Y. (Age 21.) Refers to E. F. Barry, E. F. Church.

COWGILL, JOSEPH MORELAND, Paulsboro, N.J. (Age 21.) Refers to T. H. Evans, E. W. Saunders.

COX, KENNETH CHARLES, Clinton, Iowa. (Age 21.) Under Eng. Aide, U. S. Engrs., Hydraulic Sec., Rock Island, Ill. Refers to F. M. Dawson, A. H. Holt, R. B. Kittredge, B. J. Lambert, E. L. Waterman, H. E. Wessman.

CROOK, STANLEY FRANKLIN, Rome, N.Y. (Age 24.) Refers to H. Bouchard, L. M. Gram, A. A. Jakkula, L. C. Maugh, H. E. Riggs, C. O. Wisler.

CRUICKSHANKS, JOHN STIRLING, JR., Richmond, Va. (Age 22.) Refers to R. B. H. Begg, F. J. Sette.

CULP, DENNIS KING, Wenatchee, Wash. (Age 24.) Refers to G. E. Hawthorn, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

CULTICE, JAMES MARVIN, Washington, D.C. (Age 29.) Asst. Engr., Resettlement Administration. Refers to R. B. H. Begg, F. J. Sette.

CUNNINGHAM, MURRAY HUNT, Bloomington, Tex. (Age 21.) With Humble Oil & Refining Co. Refers to B. W. Pegues, F. F. Pillet.

DEKEMA, JACOB, Los Angeles, Calif. (Age 22.) Refers to R. M. Fox, D. M. Wilson.

DIETER, FRANK LOUIS, Arlington, Va. (Age 33.) Associate Engr. and Civ. Engr., Resettlement Administration, Div. of Suburban Resettlement, U. S. Dept. of Agriculture. Refers to B. E. Brevik, J. L. Crane, Jr., W. E. Kroening, W. Landsiedel, C. D. Putnam, W. R. Reuter, H. C. Webster.

DISKANT, ROBERT, Philadelphia, Pa. (Age 22.) Refers to H. L. Bowman, R. V. Giles.

DIVER, HARRISON MORTON, JR., Baltimore, Md. (Age 21.) Refers to T. F. Comber, T. F. Hubbard, F. W. Medaugh, J. T. Thompson.

DOBBIN, JOHN RALPH, Edmond, Kans. (Age 25.) Chainman, Kansas State Highway Comm. Refers to L. E. Conrad, E. R. Dawley, F. F. Frazier, M. W. Furr, R. F. Morse, L. V. White.

DURRAYK, ADIL GABRIEL, Lebanon, Syria. (Age 25.) Refers to J. H. Cissel, L. M. Gram, A. A. Jakkula, L. C. Maugh, R. H. Sherlock.

EDWARDS, WILLIAM HERBERT, Lakeview, Ore. (Age 32.) Levelman, U. S. Bureau of Public Roads. Refers to J. R. Griffith, F. Merryfield, C. A. Mockmore.

ELLARSON, RICHARD LAWRENCE, Ellensburg, Wash. (Age 23.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

ENDRES, GEORGE BEN, Seattle, Wash. (Age 27.) Refers to A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

ERICKSON, HAROLD VERNER, Topeka, Kans. (Age 29.) Instrumentman, Kansas State Highway Comm. Refers to E. Boyce, W. K. Dinklage, W. C. McNown, F. A. Russell, R. B. Wills.

ESTERMAN, JOSEPH MICHAEL, Sacramento, Calif. (Age 29.) Senior Eng. Aid, California Statewide Highway Planning Survey. Refers to R. L. Allin, A. H. Brownfield, C. Derleth, Jr., B. A. Etcheverry, S. T. Harding.

FAIIA, SALVATORE ANTHONY, Waterbury, Conn. (Age 22.) Refers to C. T. Schwarze, D. S. Trowbridge.

FAVRET, HAROLD FRANCIS, New Orleans, La. (Age 22.) Refers to E. S. Bres, D. Derickson.

FERNS, JOHN HAMILTON, San Francisco, Calif. (Age 29.) Jun. Highway Engr., Bridge Dept., California State Div. of Highways, Sacramento, Calif. Refers to E. C. Bissell, F. W. Panhorst, A. L. Richardson.

FICHTMUELLER, FREDERICK ADOLPH, Staten Island, N.Y. (Age 24.) Refers to H. K. Dimelow, F. P. Witmer.

FOSTER, EDGAR EUGENE, Boston, Mass. (Age 43.) With U. S. Engineer Dept. Refers to J. E. Allen, H. J. Casey, F. P. Fifer, P. F. Kruse, R. M. McCrone, F. Nebiker, J. S. Stratton, R. M. Strohl.

FOSTER, RICHARD, Valley City, N.Dak. (Age 27). With North Dakota Highway Dept. Refers to H. M. Fitch, W. E. Smith.

FOSTER, ROBERT FRANKLIN, Mahomet, Ill. (Age 23.) Refers to W. C. Huntington, T. C. Shedd.

FRARACCIO, PASCO, Providence, R.I. (Age 22.) With State of Rhode Island on surveying. Refers to C. Billmyer, F. W. Stubbs.

FRATAR, THOMAS JOSEPH, Pelham, N.Y. (Age 24.) Instrumentman with Madigan-Hyland, New York City. Refers to L. W. Clark, H. O. Sharp.

GAITHER, CORNELIUS GORDON, Mays Lick, Ky. (Age 24.) Refers to W. J. Carrel, D. V. Terrell.

GERMAN, ROBERT MONROE, Vicksburg, Miss. (Age 27.) Jun. Civ. Engr., U. S. Waterways Experiment Station. Refers to S. J. Buchanan, G. R. Clemens, H. A. Sargent, H. D. Vogel, C. P. Wright.

GILLAM, WILLIAM ALFRED, Seattle, Wash. (Age 22.) Refers to G. E. Hawthorn, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

GLEASON, ROBERT JOSEPH, Glens Falls, N.Y. (Age 29.) Jun. San. Engr., Dist. Office, New York State Dept. of Health, Glens Falls, N.Y. Refers to L. V. Carpenter, L. G. Lenert, A. P. Miller, T. Saville.

HANSEN, CHRISTIAN ANTHONY, Guelph N.Dak. (Age 21.) Refers to H. M. Fitch, W. E. Smith.

HAPPY, VIRGIL LEE, Casper, Wyo. (Age 25.) Chainman, Bureau of Reclamation. Refers to R. D. Goodrich, H. T. Person.

HARTSFIELD, MARVIN FURR, Oxford, Miss. (Age 23.) Constr. Engr. for V. C. Cagle. Refers to A. B. Hargis, G. E. Tomlinson.

HARVEY, FRANCIS STEPHEN, New York City. (Age 22.) Refers to A. W. French, J. W. Howe.

HASTINGS, DAVID CANFIELD, Richmond, Va. (Age 21.) Refers to J. A. Anderson, F. L. Nicholson, P. A. Rice.

HASTINGS, GEORGE CORL, Yellow Springs, Ohio. (Age 26.) Refers to F. E. Fahy, J. A. K. van Hasselt.

HEISEL, FREDERICK FRANK, Park Rapids, Minn. (Age 24.) Refers to H. M. Fitch, W. E. Smith.

HENDERSON, LOYAL REID, Asbury Park, N.J. (Age 21.) Refers to W. C. Sadler, J. S. Worley.

HENSHAW, JESSE ROBINSON, Portland, Ore. (Age 24.) Sales Engr., Pure Iron Culvert & Mfg. Co. Refers to J. R. Griffith, C. I. Grimm, J. C. Stevens.

HICKMAN, RICHARD EDGAR, Knoxville, Tenn. (Age 23.) Eng. Draftsman, TVA. Refers to W. C. Voss, L. B. Westfall.

HOUSTON, MARION LUTHER, Lawrenceville, Ill. (Age 36.) Jun. Engr., Illinois Div. of Highways. Refers to G. H. Anderson, F. R. Friedewald, R. E. Hutchins, R. L. McCormick, B. C. McCurdy, A. P. Poirot.

Huff, George Russell, Wenatchee, Wash. (Age 26.) Rodman, Washington State Highway Dept. Refers to H. E. Phelps, M. K. Snyder.

Hull, Richard Niles, Laramie, Wyo. (Age 23.) With Howard F. Bell, Cody, Wyo. Refers to H. F. Bell, H. T. Person.

Hunt, Gilbert Agnew, Brooklyn, N.Y. (Age 45.) Hydr. Engr., Phoenix Eng. Corporation, New York City. Refers to R. W. Burpee, P. E. Gisiger, L. M. Gram, A. T. Larned, B. Moreell, W. H. Smith, L. A. Whitsit.

Hunter, Claude Earl, Jr., Reno, Nev. (Age 23.) Refers to F. L. Bixby, H. P. Boardman.

Huston, Klyde Zieglar, Oklahoma City, Okla. (Age 21.) Refers to W. L. Benham, J. E. Kirkham, E. R. Stapley.

Jenks, Downing Bland, St. Paul, Minn. (Age 22.) Refers to R. H. Suttie, C. F. Thomas.

Jensen, Ray, San Marino, Calif. (Age 22.) Refers to R. R. Martel, F. Thomas.

Joe, Alvin Kay Yip, Bakersfield, Calif. (Age 23.) Refers to H. E. Davis, B. A. Etcheverry, M. P. O'Brien.

Jones, Robert Enderlin, Philadelphia, Pa. (Age 22.) Refers to H. C. Berry, F. P. Witmer.

Kallgren, Harry Richard, Detroit, Mich. (Age 39.) Asst. Civ. Engr., Dept. of Public Works. Refers to M. R. Fisher, A. B. Morrill, F. E. Simpson, F. H. Stephenson, M. F. Wagnitz, L. C. Wilcoxen.

Kaufman, Walter Jackson, Jr., Elizabeth, N.J. (Age 22.) Refers to T. F. Hubbard, J. T. Thompson.

Kelsh, Lawrence John, Portland, Ore. (Age 27.) Refers to J. R. Griffith, F. Merryfield, C. A. Mockmore.

Kilian, William Thomas, Manhattan, Kans. (Age 23.) Chainman, Kansas State Highway Comm. Refers to L. E. Conrad, M. W. Furr.

Kinney, Charles Wesley, New Orleans, La. (Age 27.) Jun. Civ. Engr., U. S. Public Health Service. Refers to J. O. Jones, H. N. Old, F. A. Russell, W. L. Voorduin, D. M. Wood.

Kirkpatrick, Kenneth William, Knoxville Tenn. (Age 22.) Jun. Eng. Aide, TVA. Refers to J. W. Howe, R. B. Kittredge, B. J. Lambert, C. J. Posey, E. L. Waterman, C. C. Williams.

Kirpich, Zalmon, Brooklyn, N.Y. (Age 22.) Jun. Engr., U. S. Engr. Office, New York City. Refers to W. H. Chorlton, E. M. Graf, I. Gutmann, W. S. Pardoe, F. P. Witmer.

Knight, Allan Walton, Hobart, Tasmania, Australia. (Age 27.) Engr., Public Works Dept. Refers to C. C. Halkyard, H. M. Sherrard.

Knight, Ralph Edward, Seattle, Wash. (Age 27.) Refers to A. L. Miller, C. C. More.

Kovtynovich, John, Oswego, Ore. (Age 22.) Refers to F. Merryfield, C. A. Mockmore.

Kunitzky, Frederick, Bronx, N.Y. (Age 20.) Refers to C. T. Schwarze, D. S. Trowbridge.

Lager, Fred, Bronx, N.Y. (Age 20.) Refers to L. V. Carpenter, A. Haring, T. Saville, C. T. Schwarze, D. S. Trowbridge.

Laine, Leo Lauri, Memphis, Tenn. (Age 27.) Jun. Engr., U. S. Geological Survey, acting as Res. Engr. Refers to W. E. Dickinson, J. H. Gardiner, J. S. Gatewood, F. C. Kelton, G. L. McLane, C. G. Paulsen.

Laird, Knight, Jonesboro, Ark. (Age 25.) Refers to H. C. Bird, W. H. Hall, W. M. Piatt.

Lavergne, Emile Denis, Shawinigan Falls, Que., Canada. (Age 27.) Refers to J. H. Cissel, A. A. Jakkula, L. C. Maugh, R. H. Sherlock.

Lewis, Stanley Joseph, Monroe City, Tex. (Age 21.) Refers to B. W. Pegues, F. F. Pillet.

Linden, Arthur Richard, Seattle, Wash. (Age 23.) Refers to G. E. Hawthorn, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

Lipschutz, Daniel, Raleigh, N.C. (Age 22.) Jun. Draftsman, N. C. State Highway & Public Works Comm. Refers to T. F. Hickerson, R. M. Trimble.

Lix, Joseph Daniel, Washington, D.C. (Age 23.) Refers to F. A. Biberstein, Jr., A. J. Scullen.

Locantore, Stephen Sylvester, New York City. (Age 24.) Surveyman, Engr. Office, U. S. Army, 1st New York Dist. Refers to W. Allan, R. E. Goodwin.

Lockwood, Bradley Franklin, Jr., Savanna, Ill. (Age 23.) Rodman, Chicago, Milwaukee, St. Paul & Pacific R.R. Refers to A. A. Chenoweth, E. D. Dake.

Longhi, Edward John, Mt. Vernon, N.Y. (Age 23.) Refers to L. V. Carpenter, C. T. Schwarze, D. S. Trowbridge.

McCaffrey, William Theodore, Pond Eddy, N.Y. (Age 25.) Refers to L. M. Gram, A. A. Jakkula, L. C. Maugh, C. O. Wisler.

McClure, William Carter, Seattle, Wash. (Age 20.) Refers to F. B. Farquharson, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

McMahan, Leonard Clyde, Jr., Monroe, Wash. (Age 25.) Refers to C. W. Harris, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

Mapes, Joe Burkett, Post, Tex. (Age 23.) With Texas Highway Dept. Refers to J. H. Murdough, G. W. Parkhill.

Marsh, James Spencer, Portland, Ore. (Age 23.) Refers to J. R. Griffith, F. Merryfield, C. A. Mockmore.

Martinek, Richard William, Neenah, Wis. (Age 22.) Refers to F. R. McMillan, G. A. Maney.

Mayfield, Isaac Newton, Borger, Tex. (Age 24.) Engr. at Alamo Refinery, Phillips Petroleum Co. Refers to P. M. Ferguson, S. P. Finch.

Miller, Edward Luther, Wilmington, Del. (Age 22.) Refers to E. F. Coddington, C. T. Morris.

Milner, Frank, West Lafayette, Ind. (Age 21.) Graduate Asst., Purdue Univ.—State Highway Comm. of Indiana Joint Highway Research Project. Refers to C. A. Ellis, R. B. Wiley.

Mittet, Holger Peter, Seattle, Wash. (Age 21.) Refers to A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler, R. B. Van Horn.

Montgomery, Robert Grove, Grand Rapids, Mich. (Age 21.) Refers to L. C. Maugh, W. C. Sadler.

Moore, Bernard Caldwell, Forest Hills, N.Y. (Age 24.) Refers to J. J. Chamberlain, Jr., B. T. Schad.

Murray, Allen Brainerd, Richland, Wash. (Age 24.) Refers to H. E. Phelps, M. K. Snyder, J. G. Woodburn.

Murray, William Henry, Berkeley, Calif. (Age 24.) Refers to F. S. Foote, C. G. Hyde, B. Jameyson.

Myers, Edwin DeMond, Marion, Ind. (Age 22.) Refers to W. W. Fineren, B. M. Johnson, T. M. Lowe, P. L. Reed, W. L. Sawyer.

Norrie, Kenneth Peter, Olympia, Wash. (Age 24.) Refers to E. C. Dohm, A. Johnson, H. E. Phelps, M. K. Snyder, J. G. Woodburn.

O'Donnell, Henry Patrick, Spokane, Wash. (Age 33.) Refers to G. E. Hawthorn, R. G. Hennes, F. Mears, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

O'Fallon, John Emmett, Steamboat Springs, Colo. (Age 23.) Senior Rodman, U. S. Bureau of Public Roads. Refers to E. O. Bergman, R. L. Downing, C. L. Eckel, E. W. Raeder, W. H. Thoman.

Osborn, Caleb Ellsworth, Jr., Columbus, Ohio. (Age 31.) Sales Engr., Rensselaer Valve Co., Troy, N.Y. Refers to V. A. Eberly, H. H. Hawley, J. M. Montz, J. C. Prior, J. R. Shank, W. G. Smith.

Osoffsky, Jake, Sacramento, Calif. (Age 23.) Asst. to Joseph W. Gross, Municipal and Reclamation Engr. Refers to C. Derleth, Jr., J. W. Gross.

Palmer, Robert Kent, Schenectady, N.Y. (Age 22.) Refers to T. R. Lawson, H. O. Sharp.

Paterson, John Lamb, Shanghai, China. (Age 36.) Member of firm and Chf. Engr., Palmer & Turner, Archts. & Civ. Engrs. Refers to H. Berents, S. E. Faber, P. N. Fawcett, R. Freeman, C. Harpur, L. M. Pharis, J. W. Young.

Paules, Earl Carpenter, Berkeley, Calif. (Age 22.) With Pacific Gas & Elec. Co., San Francisco, Calif. Refers to T. J. Corwin, Jr., C. Derleth, Jr., B. A. Etcheverry, S. T. Harding, C. T. Wiskocil.

Planas y Valdes, Juan Ignacio, Havana, Cuba. (Age 26.) Refers to E. J. Chibas, G. N. Cox, F. J. Gaston, B. W. Pegues, F. F. Pillet, M. Villa Rivera.

Porter, William Henry, Memphis, Tenn. (Age 23.) Refers to A. B. Hargis, N. H. Rector.

Preston, Howard Kent, Jr., Trenton, N.J. (Age 22.) Detailer, American Bridge Co. Refers to C. E. Grubb, T. D. Mylrea.

Rawlins, Joe Charles, Shreveport, La. (Age 27.) With Pipe Dept., Standard Oil Co. of Louisana. Refers to E. C. H. Bantel, P. M. Ferguson, S. P. Finch, J. A. Focht, B. McLaurin.

Reed, James Allen, Pueblo, Colo. (Age 25.) Refers to R. D. Goodrich, H. T. Person.

Reeve, John Orson, Salmon, Idaho. (Age 25.) Jun. Engr., U. S. Forest Service on CCC work. Refers to T. C. Adams, R. B. Ketchum, J. P. Martin, R. R. Mitchell, J. H. Smith.

Reinhold, Richard Samuel, Salt Lake City, Utah. (Age 23.) Refers to T. C. Adams, R. B. Ketchum, F. H. Richardson.

Richards, John Ashhurst, Pottsville, Pa. (Age 22.) Refers to C. T. Bishop, R. H. Suttie.

Riepe, Carl Ripley, LaCrosse, Wis. (Age 21.) With Chicago, Burlington & Quincy R.R. Refers to R. A. Caughey, R. A. Moyer.

Ritter, Roy Horace, Baltimore, Md. (Age 33.) With Whitman Requardt & Smith on Baltimore sewage-disposal project. Refers to F. A. Barnes, L. R. Howson, G. J. Requardt, M. E. Scheidt, E. B. Whitman.

Rittman, Henry Thomas, Jr., Hackensack, N.J. (Age 23.) Refers to C. L. Crandall, H. N. Lendall.

Robinson, Leigh Edward, Buffalo, N.Y. (Age 22.) Refers to R. B. Kittredge, B. J. Lambert.

Romeo, Anthony Frank, Astoria, N.Y. (Age 20.) Refers to W. Allan, L. C. Pope.

Rosenfeld, Yale, San Francisco, Calif. (Age 22.) Refers to C. G. Hyde, B. Jameyson.

Ross, Austin Holmes, Middlebury, Vt. (Age 21.) Refers to G. F. Eckhard, D. W. Overocker.

Rowland, Henry Cottrell, Jr., South Bristol Maine. (Age 24.) Refers to C. T. Bishop, C. S Farnham, R. S. Kirby, P. G. Laurson, R. H. Suttie, C. J. Tilden.

Rouze, Robert Edward, Seattle, Wash. (Age 23.) Refers to G. E. Hawthorn, C. C. More, F. H. Rhodes, Jr. R. G. Tyler, R. B. Van Horn.

Russell, John Tucker, Romford, Essex, England. (Age 28.) Sec. Engr. on 3 contracts for additional purification plan construction at London County Council northern outfall works. Refers to A. L. Harvey, E. S. Sheiry, W. E. Smith, E. R. Stivers, C. H. Sutherland.

Ruzek, Charles V., Jr., San Francisco, Calif. (Age 21.) Refers to J. R. Griffith, G. W. Holcomb, F. Merryfield, C. A. Mockmore.

Ruzika, Joseph William, Jr., Lyndhurst, N.J. (Age 23.) Refers to A. M. Erickson, A. Haring, C. T. Schwarze, D. S. Trowbridge, S. F. Yasines.

Saenz, Mateo, New York City. (Age 20.) Refers to C. T. Schwarze, D. S. Trowbridge.

Saltman, Murdie, High Island, Tex. (Age 24.) Refers to A. Boyd, E. F. Chandler.

Sanders, Azel Labon Ralph, Chicago, Ill. (Age 38.) Asst. Engr. with Hazel & Erdel, Cons. Engrs., Chicago, Ill. Refers to H. Cross, C. P. Hazelet, G. Jeppesen, W. E. Lofgren, W. M. Wilson.

Sanzenbacher, William Phillip, Toledo, Ohio. (Age 26.) With Forster-Wernert-Taylor, Industrial Engrs. Refers to G. Champe, A. S. Forster, W. H. Hasselbach, A. A. Jakkula, H. W. Knox, P. W. McDonnell, C. B. Patterson.

Savage, Frank Dee, Houston, Tex. (Age 23.) Draftsman, Gulf Prod. Div., Gulf Oil Corporation. Refers to E. C. H. Bantel, P. M. Ferguson, S. P. Finch, J. A. Focht.

Sayler, Francis Albert, Los Angeles, Calif. (Age 26.) Refers to R. M. Fox, D. M. Wilson.

Schrader, Otto William, San Francisco, Calif. (Age 23.) Refers to C. G. Hyde, B. Jameyson.

Seeley, Ralph Kinne, Caro, Mich. (Age 21.) Refers to L. C. Maugh, R. H. Sherlock.

Segal, William Howard, New York City. (Age 22.) Jun. Engr. U. S. Engr's. Office. Refers to W. Allan, R. E. Goodwin, C. Rathbun, W. L. Willig.

Semidey, Hector Jose, New York City. (Age 23.) Refers to C. T. Schwarze, D. S. Trowbridge.

Serrurier, Mark Usona, Hollywood, Calif. (Age 33.) Structural Designer, California Inst. of Technology, Pasadena, Calif. Refers to R. W. Binder, O. G. Bowen, F. J. Converse, B. A. Hill, R. R. Martel, F. Thomas.

Sewell, James Arthur, Colfax, Wash. (Age 21.) Refers to H. E. Phelps, M. K. Snyder, J. C. Stegner, J. G. Woodburn.

Shuldiner, William, New York City. (Age 20.) Refers to W. Allan, W. L. Willig.

Simmons, Floyd Henry, Midwest, Wyo. (Age 22.) Refers to R. D. Goodrich, E. K. Nelson, H. T. Person.

Sims, George Chester, Douglas, Wyo. (Age 22.) Refers to R. D. Goodrich, H. T. Person.

Smith, Fred Gehrmann, New York City. (Age 24.) Refers to F. A. Barnes, R. Y. Thatcher, C. L. Walker.

Smith, John Gordon, Oklahoma City, Okla. (Age 22.) Refers to J. E. Kirkham, E. R. Stapley.

Solander, Arvo, Axel, Winchendon, Mass. (Age 28.) Engr. with Samuel M. Ellsworth. Refers to S. M. Ellsworth, F. H. Kingsbury, A. D. Weston, E. Wright.

Spirz, William, San Francisco, Calif. (Age 35.) Refers to C. Derleth, Jr., B. A. Etcheverry, C. G. Hyde, L. O. Jahlstrom, L. J. Jennings, R. R. Rowe, C. C. Winter, L. K. Wood.

Stamm, George Woodrow, St. Louis, Mo. (Age 22.) Refers to O. W. J. Anschuetz, W. G. Brenneke, W. W. Horner, E. O. Sweetser.

Steinman, Jesse, Brooklyn, N.Y. (Age 23.) Draftsman, Robinson & Steinman, New York City. Refers to W. Allan, J. C. Rathbun.

Streithof, Charles Perry, Coraopolis, Pa. (Age 34.) Structural Engr., Dravo Contr. Co., Eng. Works Dept., Pittsburgh, Pa. Refers to G. H. Atwood, A. W. Dann, C. B. Jansen, F. M. McCullough, C. R. Tiebout.

Stucke, Vincent Chris, San Antonio, Tex. (Age 23.) With J. W. Beretta Engrs., Inc. Refers to P. M. Ferguson, J. A. Focht.

Suominen, Wilho Nestor, Sewickley, Pa. (Age 21.) Detailer, American Bridge Co., Ambridge, Pa. Refers to T. F. Hickerson, R. M. Trimble.

Tanassy, Louis, Jackson Heights, N.Y. (Age 24.) Refers to W. Allan, J. J. Theobald.

Thigpen, Hugh McGhee, New Bethlehem, Pa. (Age 33.) Surveyman, in charge of U. S. Engr. Field Office. Refers to E. R. Covell, F. J. Fitzpatrick, F. W. Hough, T. J. Mitchell, P. A. Perrin.

Thompson, William Jefferson, La Grange, Ill. (Age 27.) Draftsman, Lines East, Chicago, Burlington & Quincy R.R. Refers to R. P. Davis, W. S. Downs.

Towers, Richard Rutfred, Berlin, N.H. (Age 21.) Refers to E. W. Bowler, R. R. Skelton.

Tyler, Francis Chaplin, New Hartford, Conn. (Age 22.) Rodman, Metropolitan Water Bureau. Refers to W. R. Benford, L. T. Bohl.

Underhill, Edward Griffin, McKeesport, Pa. (Age 22.) Refers to J. K. Finch, J. A. Oakey.

Vartia, Karl Olavi, Washington, D.C. (Age 24.) Refers to O. B. French, J. R. Lapham.

Von Muller, Francis, Stapleton, S.I., N.Y. (Age 57.) Asst. Engr., Street Opening Div., Borough of Richmond. Refers to O. L. Brodie, T. S. Oxholm, V. H. Reichelt, A. W. Tidd, A. S. Tuttle, R. W. Wood.

Wahlborg, Karl Stanley, Seattle, Wash. (Age 24.) Refers to R. G. Hennes, A. L. Miller, C. C. More, F. H. Rhodes, Jr., R. G. Tyler.

Ward, James Raymond, Greenville, Tex. (Age 25.) Refers to P. M. Ferguson, J. A. Focht, A. D. Hutchison, R. W. Stiles.

Warner, Herman Ensign, Cambridge, Mass. (Age 24.) Salesman, Estimator, and Supt. with Chapman Waterproofing Co. Refers to C. T. Bishop, R. H. Suttie.

Warrington, Francis Carlton, Coraopolis, Pa. (Age 24.) Refers to T. R. Agg, R. A. Caughey, J. S. Dodds, A. H. Fuller, L. O. Stewart.

Weaver, Russell Reiss, Allentown, Pa. (Age 33.) With Bethlehem Steel Corporation. Refers to E. F. Ball, J. Farenwald, D. S. Gendell, Jr., A. R. Graves, S. Johnston, J. Jones, E. T. Wilson.

Webster, Howard Elwyn, Watertown, Mass. (Age 27.) Refers to J. B. Babcock, 3d, C. B. Breed, H. J. Casey, W. M. Fife, G. Gilboy, J. D. Mitsch, D. W. Taylor.

Weiss, Warren Hadfield, Washington, D.C. (Age 24.) Refers to F. L. Castleman, Jr., W. A. Coolidge, F. J. Lewis, S. Truscott.

Wenderoth, Henry John, Mapleton, Ore. (Age 22.) With U. S. Geological Survey. Refers to J. R. Griffith, G. W. Holcomb, F. Merryfield, C. A. Mockmore.

Wheeldon, Roscoe Gaffer, Frankfort, Ky. (Age 21.) Field Engr. on Constr. with Frank Messer & Sons, Inc., Cincinnati, Ohio. Refers to W. J. Carrell, D. V. Terrell.

Willes, Emery Hyde, Salt Lake City, Utah. (Age 22.) Refers to H. S. Carter, G. D. Clyde, O. W. Israelsen, H. R. Kepner, O. C. Lockhart.

Williams, Roy Bruce, Yuma Ariz. (Age 48 Constr. Engr., U. S. Bureau of Reclamation Refers to S. O. Harper, J. C. Page, G. O Sanford, J. L. Savage, R. F. Walter, W. R Young.

Winn, Harlan Frank, Jamestown, N.Dak (Age 23.) Refers to H. M. Fitch, W. E Smith.

Woldan, Ferdinand Zdenek, Stamford, Conn (Age 24.) Refers to C. T. Schwarze, D. S Trowbridge.

Woodruff, Richard Shaul, Birmingham, Ala (Age 24.) Refers to G. J. Davis, Jr., D. C. A du Plantier.

FOR TRANSFER

FROM THE GRADE OF ASSOCIATE MEMBER

Backes, Edward William, Assoc. M., Evanston Ill. (Elected Junior Oct. 2, 1922; Assoc. M Nov. 14, 1927.) Sales Engr. with Rail Joint Co. Refers to W. J. Backes, H. C. Bird, C W. Gennett, Jr., C. Gilman, E. Haupt, F. E Morrow, G. M. O'Rourke, W. H. Penfield, C J. Tilden, V. R. Walling.

Boni, Ovidio Augustus, Assoc. M., Manila Philippine Islands. (Elected April 23, 1928 (Age 37.) Chf. Designing Engr., Atlantic Gulf & Pacific Company of Manila. Refers to H. W. Corp, S. Garmezy, C. Russell, H. I Shoemaker, J. A. Thomas.

Donaldson, Arthur, Assoc. M., Bonneville Ore. (Elected Nov. 15, 1926.) (Age 38 Job Engr. in Charge, Columbia Constr. Co Bonneville Dam. Refers to A. H. Ayers C. F. Calhoun, R. R. Clark, F. T. Crowe, G Havas, C. A. Smith, B. E. Torpen.

Ferguson, Phil Moss, Assoc. M., Austin, Tex (Elected Junior March 15, 1926; Assoc. M Dec. 28, 1931.) Associate Prof. of Civ. Eng Univ. of Texas. Refers to E. P. Arneson, E C. H. Bantel, S. P. Finch, J. A. Focht, R. O Jameson, J. T. L. McNew, T. U. Taylor.

Harvey, Alfred Dallas, Assoc. M., Fort Peck Mont. (Elected April 15, 1929.) (Age 39.) Gen. Mgr., Spillway Bldrs., Inc., Kansas City, Mo Refers to J. F. Brown, F. M. Cortelyou, A. C Everham, C. S. Heritage, F. G. Jonah, T. B Larkin, A. N. Reece, H. P. Treadway, N. T Veatch, Jr.

Johnson, Berkeley, Assoc. M., Santa Fe, N Mex. (Elected Oct. 12, 1925.) (Age 42 Dist. Engr., Surface Water Div., Water Resources Branch, U. S. Geological Survey Refers to N. C. Grover, H. C. Neuffer, C. G Paulsen, F. C. Scobey, H. M. Stafford

Kennedy, George Donald, Assoc. M., Lansing Mich. (Elected March 15, 1926) (Age 37 With Michigan State Highway Dept. as 1st Deputy State Highway Commr. Refers to J. H. Cissell, M. E. Cooley, G. H. Fenkell L. M. Gram, W. C. Hoad, L. G. Lenhardt H. S. Morse, J. R. Pollock, H. E. Riggs

McCrosky, Theodore Tremain, Assoc. M Yonkers, N.Y. (Elected Junior Feb. 25, 1924 Assoc. M. Oct. 29, 1934.) (Age 35.) Planning Director, City Planning Comm., Secy. and Executive Officer, Municipal Housing Authority, Yonkers, N.Y. Tech. Consultant Mayor's Comm. on City Planning, New York City. Refers to E. P. Goodrich, A. P. Hoover P. G. Laurson, H. M. Lewis, C. J. Sheridan C. J. Tilden, J. C. Tracy.

Moore, Norman Robert, Assoc. M., Vicksburg Miss. (Elected Junior April 23, 1928; Assoc M. Jan. 26, 1931.) (Age 37.) Engr., U. S Engr. Office. Refers to A. L. Alin, O. G. Baxter, W. Gerig, J. D. Justin, T. T. Knappen W. H. McAlpine, A. L. Pauls.

Noble, Mont Cagley, Assoc. M., Springfield Ill. (Elected Aug. 30, 1926.) (Age 43 Gen. Mgr., The W. Q. O'Neall Co. of Illinois Refers to D. L. Erickson, R. M. Green, R. O Green, G. E. Johnson, A. Marston, D. D Price.

Rasmussen, Rasmus, Assoc. M., San Francisco Calif. (Elected Jan. 17, 1921.) (Age 53 Dist. Mgr., Bates & Rogers Constr. Co

Chicago, Ill. Refers to C. E. Andrew, F. L. Copeland, L. F. Harza, W. A. Rogers, F. L. Thompson, C. C. Westfall, G. B. Woodruff.

Tilly, Ray Virgil, Assoc. M., Springfield, Ill. (Elected Junior Jan. 19, 1925; Assoc. M. Dec. 3, 1928.) (Age 41.) Cons. Engr. and member of firm, Wood, Walraven & Tilly, Civ. and Struc. Engrs. Refers to A. Boyd, G. F. Burch, E. F. Chandler, J. K. Giesey, A. Johnson, R. L. Whannel.

From the Grade of Junior

Appel, Theodore Burton, Jr., Jun., Fountain City, Tenn. (Elected Nov. 11, 1929.) (Age 32.) With Constr. Plant Div., TVA, Knoxville, Tenn. Refers to J. B. Babcock, 3d, R. T. Colburn, R. R. Graham, L. A. Schmidt, Jr., W. L. Stevenson.

Cookman, Willard George Minter, Jun., Utica, Ill. (Elected Sept. 14, 1936.) (Age 30.) Inspector (Dredge), U. S. Engr. Dept. Refers to E. H. Beechley, E. H. Coe, D. H. Connolly, W. K. Hatt, S. N. Karrick, F. T. Sheets, R. B. Wiley.

Hicks, Ralph Comstock, Jun., Albion, Mich. (Elected May 25, 1931.) (Age 32.) Refers to C. O. Carey, R. E. Horton, H. S. Hunt, C. T. Johnston, A. Streiff, R. S. Swinton, C. O. Wisler.

Hsu, Chien, Jun., Sihsien, Anhwei, China. (Elected Dec. 13, 1928.) (Age 32.) Dist. Engr., Nanking-Kiangsi Ry. Refers to F. A. Barnes, F. K. Shore, R. Y. Thatcher, W. G. B. Thompson, F-Y. Tsai, C. L. Walker.

Larson, Donald Edward, Jun., Chicago, Ill. (Elected Oct. 14, 1930.) (Age 32.) Development Engr., Chicago Bridge & Iron Co. Refers to H. C. Boardman, H. Cross, G. T. Horton, W. C. Huntington, C. S. Pillsbury, M. J. Trees, W. M. Wilson.

Pilkey, Orrin Hendron, Jun., Chicago, Ill. (Elected Oct. 14, 1930.) (Age 32.) Development Engr., Chicago Bridge & Iron Co. Refers to R. M. Burkhalter, H. Cross, S. Hardesty, E. L. MacDonald, E. R. Needles, C. S. Pillsbury, J. A. L. Waddell.

Prothero, Maurice Raymond, Jun., Jacksonville, Fla. (Elected Nov. 15, 1926.) (Age 32.) Asst. Engr., U. S. Engr. Dept. Refers to R. M. Angas, B. C. Dunn, M. C. Prichard, C. C. Schrontz, G. A. Youngberg.

Ranlett, Charles Augustus, Jr., Jun., Sharon Hill, Pa. (Elected Aug. 15, 1932.) (Age 32.) Chf. of Party with Damon & Foster, Civ. & Cons. Engrs. Refers to E. W. Backes, N. Foster, J. T. Kiernan, A. G. Milan, D. B. Zentmyer.

Thomas, Mark Everett, Jun., Willits, Calif. (Elected Oct. 1, 1926.) (Age 32.) Capt., Organized Reserve Corps, CCC; in charge of camp; Dist. Finance Officer. Refers to S. A. Chapman, C. M. Kerr, S. P. Laverty, L. B. Reynolds, C. B. Wing.

Topping, Charles Hinchman, Jun., Galveston, Tex. (Elected Nov. 11, 1929.) (Age 33.) Designer, Pan American Refining Corporation. Refers to C. L. Bogert, A. M. McKean, G. M. Neel, C. M. Spofford, T. H. Wiggin, R. R. Wiggins.

Vollmer, Alexander Russell, Jun., Baltimore, Md. (Elected March 5, 1928.) (Age 31.) Asst. Engr. with Whitman, Requardt & Smith. Refers to F. A. Barnes, W. H. Collisson, Jr., V. Gelineau, L. R. Howson, B. L. Smith, E. B. Whitman, C. G. Wigley.

The Board of Direction will consider the applications in this list not less than thirty days after the date of issue.

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 87 of the 1937 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when it should be sent to the office designated.

Construction

Engineer-Contractor; M. Am. Soc. C.E.; Cornell graduate; long experience in charge of work on highway construction; highway bridges; paving; railroad maintenance and construction; concrete construction; rock excavation; estimating and bidding jobs; cost keeping and organization of work. Desires connection in New York State outside New York City. C-119.

Design

Designing Engineer; M. Am. Soc. C.E.; over 35 years experience in the design and construction of both steel and concrete bridges and kindred structures; in the past 10 years have designed and directed the construction of bridges, viaducts, and grade-separation projects totaling over $8,000,000; continuous type totaling some $4,000,000. Now unemployed. C-108.

Specification Writer, Designer; Jun. Am. Soc. C.E.; 32; A.B. in C.E.; 4 years in responsible charge of water-supply and structural design, including preparation of specifications; 3 years building and pipeline construction; 2 years chief of survey party, highway and pole-line location. C-114.

Hydraulic Structure Designer; Jun. Am. Soc. C.E.; B.S.C.E., University of Illinois; married; age 32. Engineer in charge, design of high masonry dam for Army Engineers, also checking plans for hydroelectric developments of Aluminum Company. Ability to write and talk on technical subjects. Desires permanent engineering position in design or as an executive. C-130.

Structural; Jun. Am. Soc. C.E.; 31; married; B.S. degree in civil engineering; registered professional engineer, state of Iowa; experienced in design and construction of both plain and reinforced-concrete structures; desires connection with private corporation or engineering firm coordinating the work of field and office; prefers Mid-West or West Coast location. C-134.

Executive

Executive, Construction Manager, Chief Engineer, General Superintendent; M. Am. Soc. C.E.; civil engineer with legal knowledge. Now chief engineer. Over 25 years extensive domestic and foreign experience, principally supervising, for builders, heavy engineering construction and building structures—many types, some of very large dimensions. Excellent health; "go-getter" for economic methods and quality construction. C-104.

Water Works Designing, Construction, and Operating Engineer; M. Am. Soc. C.E.; registered in Pennsylvania and West Virginia; 27 years experience with public utilities. Can handle design, purchase of materials and equipment, construction and placing in operation. At present employed as consulting water engineer, public service commission, West Virginia, evaluating water utilities. Available September 1, 1937. C-111.

Civil Engineer; M. Am. Soc. C.E.; graduate, registered professional engineer, state of Ohio; 27 years experience in railroad, valuation, highways, sanitary, general building construction. Lately in executive position with federal government. Desires permanent connection. Married. Excellent health. Best fitted for administrative, organizing, or operating tasks. Available immediately. C-115.

Structural Engineer; M. Am. Soc. C.E.; 36; B.S. in C.E., 1924; Phi Kappa Phi honorary; registered professional engineer; good health; married; 17 years experience in design and construction of roads and bridge; 6 years experience in structural welding. Ability to write and talk on technical subjects. Available on very short notice. C-117.

City Planning; Jun. Am. Soc. C.E.; married; B.S.C.E., University of Michigan, 1932; solid background of hard work in laboratory, steel mill, construction, plant operation; U.S.G.S.; U.S.C.; C.S.; first-lieutenant ordnance, U.S.A. reserve; planning, estimating underground utilities, including sanitary storm sewers, water mains, roads, drainage, electrical distribution system, sewage-treatment plant, incinerator, water-treatment plant. Employed. C-122.

City Manager or Purchasing Agent; M. Am. Soc. C.E.; 67; graduate of Ohio State University, 1893; 17 years in municipal work as city manager, director of public service, city engineer, and purchasing agent; 10 years on railroads as division engineer; 13 years in private practice. Southwest territory preferred. C-123.

Supervising Engineer; M. Am. Soc. C.E.; sales, engineering, and plant management of steel-fabricating industry—over 20 years experience, western Pennsylvania, Ohio, and West Virginia. C-127.

Civil Engineer; Assoc. M. Am. Soc. C.E.; B.Sc. degree; professional license; 47; married. Has been in charge of design of commercial and industrial buildings, sewage and water-treatment plants, bridges, indeterminate structures; resident engineer on important work; engineering instructor, state university. Desires responsible position with firm of contractors or consultants. C-125.

Junior

Civil Engineer; Assoc. M. Am. Soc. C.E.; technical graduate; registered; married; protestant; 22 years experience with contractors. Estimating and contracting highway bridges, water and sewer lines, filtration and sewage-disposal plants. Good knowledge of office procedure. Now employed. Prefers connection with contractor. C-103.

Civil Engineer; 25; B.C.E., Brooklyn Polytechnic Institute, 1933; graduate work in indeterminate structures, reinforced concrete, and bridge engineering. Experience consists of 3½ years in topographical surveying, drafting, and location engineering for difficult work. Single and ready to travel anywhere. C-106.

Civil Engineer; Jun. Am. Soc. C.E.; 28; single; B.S. in C.E., Manhattan College, 1932; 2½ years as chief of party and assistant engineer; one year in complete charge of conducting soil tests. Extensive reading on soil mechanics. Desires position with firm engaged in soil investigation, highway, or foundation work. C-105.

Civil Engineer; 21; single; B.S. in C.E., Cooper Union Institute of Technology, June 1937; also architectural training. Desires opportunity in any branch of civil engineering. Location immaterial, if salary is reasonable. C-107.

Civil Engineer; Jun. Am. Soc. C.E.; 26; single; B.S.C.E., New York University; study in water supply and sanitary engineering. 6 months experience as assistant town assessor; 3 months experience as town inspector in construction work. Desires position in either sanitary engineering or construction work. Excellent references. Location, New York City or vicinity. C-112.

Civil Engineering Graduate; Jun. Am. Soc. C.E.; 24; married; B.S. in C.E. degree. One year as assistant contractor's engineer. Experience in estimating, timekeeping, cost keeping, and some drafting. Wants outside job, anywhere. Prefer New York City vicinity. Available in one week. C-116.

Young Engineer; 24; graduate of Vanderbilt University in civil engineering; desires position in large construction company. Interested in steel and concrete design and construction and foreign work. Has fair knowledge of Spanish. Has also done all kinds of clerical work and typing. C-118.

Refinery Inspection Engineer; Assoc. M. Am. Soc. C.E.; M.S.C.E.; C.E.; 35; desires more responsible position. Associate C.E. rating, U. S. Civil Service; technical publications, patents to credit; 7 years with large Middle-West oil company; 5 years in charge and qualified to supervise planning and performance of refinery inspection work. Also qualified for miscellaneous refinery design. C-121.

Civil Engineer; Jun. Am. Soc. C.E.; 25; married; B.S. in C.E., Lehigh University, 1933, high honors; 3 summers as assistant in surveying school; 4 years on rolled-earth dams and concrete work (including surveying, inspection, and 2 years in charge of soils and concrete laboratory). Desires position with engineering or industrial firm. C-126.

Civil Engineer; Jun. Am. Soc. C.E.; 27; single; B.S.C.E., University of Colorado, 1935; 2 years experience; 11 months on location and construction of canals, pipelines, reservoir, and filter plant on large water-supply project; 14 months on highway location and construction; desires steady position as junior civil engineer. Available on 2 weeks notice. C-128.

Civil Engineer; Jun. Am. Soc. C.E.; 29; married; C.E., Rensselaer Polytechnic Institute, 1931. With U. S. Army Engineers; 1 year on survey work, 3 years in office on special reports and estimates. Desires work in sanitary, construction, or industrial engineering. Experience to be gained and future are important considerations—not salary. Location anywhere. Available on 2 weeks notice. C-129.

Construction Engineer; Jun. Am. Soc. C.E.; S.B. in building engineering and construction, Massachusetts Institute of Technology; 2 years experience as assistant and general secretary to general contractor. Had charge of office and bookkeeping work; kept cost records; estimated and prepared plans and specifications; supervised construction jobs. Employed now and during past year as construction safety engineer with insurance company. C-131.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; B.S.E.; M.S. in C.E.; age 21; graduate work in soil mechanics. Desires opportunity with future in design or instructorship. Location in eastern United States, preferably New York or vicinity. Available on short notice. C-133.

Engineer; Jun. Am. Soc. C.E.; 23; B.S. in C.E; Cooper Union Institute of Technology; 3 months field work in plumbing inspection with U. S. Public Health Service; 6 months topographic draftsman on flood control project; now employed in U. S. Civil Service; seeks private employment and opportunity to prove merit; locality preferably outdoors or rural. C-135.

Miscellaneous

Civil Engineer; M. Am. Soc. C.E.; married; excellent health; graduate with C.E. degree; 20 years experience in railroad and building construction and valuation work. Now in government service. Desires position in valuation work or as maintenance engineer. C-124.

Teaching

Instructor, Civil and Highway Engineering; Jun. Am. Soc. C.E.; 31; single; C.E. degree, Pennsylvania State College; majored in highway engineering; minored in city planning, city manager; 5 years highway engineering, surveys, design, construction, research; 2 years instructor (engineering mathematics); experienced tutor; public speaker; engineering publicity; publication work; university faculty position desired with opportunity for research study. C-109.

Civil Engineer; Jun. Am. Soc. C.E.; 27; B.S., M.S., and C.E. degrees. Diversified experience, supervising hydraulic design of flood-control projects, teaching, and structural analysis. Advanced studies in elasticity, fluid dynamics, soil mechanics, mathematics, bacteriology, and water supply. Research in aeronautics, structures, and sewage disposal. University teaching and research position desired. C-113.

Engineer; M. Am. Soc. C.E.; Society for the Promotion of Engineering Education; M.E. Church; Masonic Lodge; B.S., C.E., and M.E. degrees; registered professional engineer (civil and structural) and surveyor; age 46; 8 years practical experience in various fields; 13 years successful teaching experience (one position); employed at present; desires position teaching civil engineering or applied mechanics, or position with consulting engineer. C-120.

Research

Concrete Technician; Assoc. M. Am. Soc. C.E.; 8 years experience as chief concrete inspector, in charge of materials-testing laboratory, and making materials and foundation investigations for large dams and other structures. Capable of taking charge of laboratory and inspection of project of any size. Author of a number of published articles on concrete. C-110.

Hydrologic Technician; M. Am. Soc. C.E.; graduate of Purdue University, 1914; C.E., 1931; 9 years as head of state department in charge of water-resources studies; last two years with federal bureau, specializing in hydrologic research; just completing 18 months investigation; interested in snow research, restoration of missing runoff records, operation studies, and open-channel hydraulics; author of various bulletins and two published papers on evaporation. C-132.

RECENT BOOKS

New books of interest to Civil Engineers donated by the publishers to the Engineering Societies Library, or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 77 of the Year Book for 1937. The notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

Abwasserfachgruppe der Deutschen Gesellschaft für Bauwesen E. V. Anweisung zur Auswertung von Schreibregenmesseraufzeichnungen für wasserwirtschaftliche Zwecke, AAR 1936 (Sonderdruck aus "Gesundheits-Ingenieur" 60, 1937). Berlin, Deutsche Gesellschaft für Bauwesen. 20 pp., diagrs., charts, tables, 12 × 8 in., paper, 1 rm.

A manual of advice upon the evaluation of rainfall data for such technical purposes as water supply, power development, etc.

Abwasserfachgruppe der Deutschen Gesellschaft für Bauwesen. Schriftenreihe Heft 3, 1937. Munich, R. Oldenbourg. 26 pp., diagrs., charts, tables, 12 × 8 in., paper, 2 rm.

This discussion of the utilization of waste waters in agriculture and gardening has been prepared as a contribution to campaign for greater food production in Germany. The properties of waste waters, their behavior in the ground, agricultural value, methods of application, and other practical questions are set forth.

Anweisung für die Durchführung von Niederschlagsmessungen (ADN 1936) aufgestellt auf Grund der Anleitung für die Beobachter an den Niederschlagsmesssatellen des Deutschen Reichswetterdienstes für Messstellen aussorhalb des Deutschen Reichswetterdienstes. Munich and Berlin, R. Oldenbourg, 1936. 23 pp., illus., diagrs., charts, tables, 11 × 8 in., paper, 2 rm.

This pamphlet contains the directions for measuring rainfall approved by the German Public Works Society. The directions are based upon the instructions issued to observers in the German Weather Bureau, which are included in this publication.

Applied Fluid Mechanics, 1 ed. By M. P. O'Brien and G. H. Hickox. New York and London, McGraw-Hill Book Co., 1937. 360 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.50.

An introductory textbook covering the usual problems of hydraulics. The authors generalize the treatment wherever possible in such a way as to make the resulting equations applicable to the flow of all true fluids. Throughout, the text stresses engineering problems from the standpoint of modern concepts of fluid mechanics.

Bridges in History and Legend. By W. J. Watson and S. R. Watson; illustrated by E. M. Watson. Cleveland (Ohio), J. H. Jansen, 1937. 248 pp., illus., 11 × 8 in., cloth, $3.50.

This attractive volume brings together a large amount of interesting information about bridges, historical and legendary. Rainbow bridges, devils' and saints' bridges, war bridges, and peace bridges are discussed with much quotation from historians and poets. There are chapters upon bridge pageants, old London Bridge, covered bridges, and toll bridges, and upon famous bridge builders. The book is illustrated by pen and ink drawings.

Deutsches Museum Abhandlungen und Berichte, Jg 9, Heft 2, 1937. Bau und Entwicklung des Erdballs. By H. Lorenz. Berlin, VDI-Verlag, 1937. 56 pp., 8 × 6 in., paper, 0.90 rm.

In this pamphlet an engineer, formerly professor of physics at Halle University, discusses the structure and evolution of the earth in simple readable language. The results of recent investigations are combined into a systematic account, which clarifies many matters.

Essentials of Engineering Astronomy. By Jerry H. Service. New York, Prentice-Hall, Inc., 1937. 167 pp., illus., tables, charts, cloth, $2.50.

Part I of this book is devoted to a survey of the underlying principles of spherical trigonometry and astronomy. This enables the reader to understand Part II which presents an observing and computing technique that insures accuracy and speed. Problems to be worked out by the reader are given, and there are references to other good literature on the subject.

Sound. By A. T. Jones. New York, D. Van Nostrand Co., 1937. 450 pp., figs., tables, diagrs., charts, tables, 9 × 6 in., cloth, $3.75.

In this elementary book on sound fundamental information is presented with historical interpolations. The subjects of sound production and transmission, free and forced vibrations, musical scales and instruments, speech and hearing are considered, with their modern technical applications. Review questions are inserted at intervals, and certain special points are covered in appendixes.